Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XL. No. 8. NEW YORK, SATURDAY, FEBRUARY 22, 1902. ISSUED WEEKLY.

ELECTRICAL REVIEW
PARK ROW BUILDING
13-21 PARK ROW - - NEW YORK
P. O. BOX 339

BY THE
ELECTRICAL REVIEW PUBLISHING COMPANY
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LONDON OFFICE
[illegible] OLD BROAD STREET, LONDON, E. C.

REGISTERED CABLE ADDRESS
"ELECTVIEW" - - NEW YORK
TELEPHONE CALL, 21 "CORTLANDT"
(PRIVATE BRANCH EXCHANGE CONNECTING ALL DEPARTMENTS)

SUBSCRIPTIONS TO THE
ELECTRICAL REVIEW

One Year, United States and Canada - - -	$3.00
One Year, Foreign Countries - - - -	5.00
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TO ADVERTISERS

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NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

Among the contributors to the Twentieth Anniversary Number of the ELECTRICAL REVIEW, which appeared last week, were three men whose labors laid the foundation for the immensely important industries of the electric railway, the electric light and electric power transmission—Messrs. Frank J. Sprague, Elihu Thomson and William Stanley. These industries have achieved a place among those contributing most to the material and social welfare of the people; they have given employment to thousands, have afforded a profitable field for enormous investments, have changed the face of cities; yet these three men are all still young and vigorous. No more interesting commentary upon the youth of the electrical arts can be made.

THE PACIFIC CABLE.

The letting of a contract for the construction of the first section of the transpacific cable, extending from San Francisco to Honolulu in the Hawaiian Islands, marks important progress in the direction of accomplishing this much desired project. It is particularly displeasing to our national pride, however, to find that the contract was let to an English manufacturer for the reason that American manufacturers are not equipped to furnish a cable of this size and character in the time desired.

A few words about the transpacific cable project may not be out of place. The present section between San Francisco and the Hawaiian Islands, which is about to be laid by the Commercial Pacific Cable Company, is the first of at least three links of cable which would be necessary to connect the western coast of the American continent with the eastern extension of the Eastern Telegraph Company's systems at Manila in the Philippine Islands. The distance from Honolulu to Manila is in the neighborhood of five thousand miles—too long a distance to work cables of the type now proven by practice to be satisfactory in transatlantic service. It is necessary, in order that signaling may proceed with sufficient speed for commercial service, to break this cable and insert a relaying station. Naturally it is important that this station should be on American ground, and the point proposed for the relaying station is the island of Guam. The section from Guam to Honolulu will still be the longest submarine cable in a single stretch in the world, being about three thousand five hundred nautical miles long.

Many years ago, when cables first began to be widely extended, a project was inaugurated to construct a line of telegraph wire upon the west coast of British Columbia and along the Alaskan peninsula, connecting by short lengths of cable with the Aleutian Islands, which form a series of stepping stones leading to a point upon the peninsula of Kamchatka. Thence the telegraph line could proceed by alternate sections of land line and short cable along the islands of the Kurile group to Yezo, the northernmost of the Japanese archipelago, and so through Japan to connect with the existing system of cables approaching that country from the West.

Of course the natural objection that could be urged against such a route is that it would include no less than four differing territories belonging to as many governments in its course. It has often been urged, but without due consideration of the facts, that the far northern route suggested makes cables laid among these islands liable to interruption by icebergs, but this is not believed to be the case by those who have carefully studied the project. While such a telegraph line would be sufficiently useful for commercial purposes its strategic and military value would be practically *nil*.

Both the British and American governments have been greatly interested in the question of transpacific cables from the purely military point of view. England is interested in the construction of an alternative cable route to Australia and the British East Indies by way of Canada and the Pacific. The United States is naturally interested in connecting its new possessions in the Pacific with the mainland, and the commerce of the world is particularly interested in anything that will give lower cable charges and swifter service to the East, where an important commerce is daily growing more and more important.

While it is vitally necessary that we should have the transpacific cable for all the reasons named above, it seems at the same time that, if possible, the cable should be of American make and laid from American cable-ships. Occasion has been taken in these columns before to comment upon

the singular fact that not one cable-ship of large dimensions flies the American flag. There is nothing in the construction of a cable-ship which would require either much time or an unreasonable amount of money, and as for cable factories, we have them already and need only the orders to go ahead and produce deep-sea cables of whatever size and capacity may be needed. Of course our cable-makers lack the experience which their British colleagues have acquired in the many years that cable-making has had its home in Great Britain, but there is nothing essentially difficult in the manufacture of deep-sea cables, and certainly no manufacturer engaged in such enterprises would hesitate about entering upon it if such opportunity presented itself.

It is to be hoped, therefore, that the subsequent links of this most important line of communication may be constructed not only by American capital but by American workmen in American shops and laid out of American cable-ships.

BLIZZARDS AND THE TELEPHONE.

In 1888 New York city and its vicinity was visited by an unprecedented fall of snow, accompanied by high winds and low temperature, which resulted in the practical destruction of the various telegraph lines leading out of the metropolis. Between New York and Boston the only line of communication was one circuit of the long-distance telephone lines and when the limit of this was reached it was found necessary to communicate to Boston by way of Valentia Bay, Ireland, and the transatlantic cables. At the same time the same storm caused such havoc with the telephone circuits in New York city that communication was greatly restricted between offices in the city itself, and practically cut off from offices in the immediate outlying suburbs.

At the time of writing, New York is again in the throes of a storm which compares in severity with the historic blizzard of 1888, and, notwithstanding this fact, telephone communication throughout the city is entirely unimpaired, while communication to its various suburbs has been delayed as a maximum only a few minutes, and this caused most likely by the inability of operators to reach the exchanges in the outlying districts on account of the unusually deep fall of snow. The first blizzard established the fact that it pays to construct good lines; the second blizzard of to-day gives one more demonstration of the immense value to a city of a thorough-going system of underground circuits placed where no accident of the weather can possibly affect them. So far as regards the outlying districts the continuity of telephone service shows that experience gained through former severe conditions of weather has been utilized and that to-day telephone construction of overhead lines has reached the point that no accident of weather can seriously interfere with them. While this statement might not hold true of trunk lines crossing particularlv exposed sections of the country, such as the Allegheny Mountains, the immense network of telephone trunk lines that has been built of late years in the vicinity of the great cities has provided so many sources of communication that no temporary accident due to the stress of weather can possibly affect its satisfactory working. The telephone companies are to be congratulated upon the outcome of the severe and unexpected test to which their equipments have just been subjected.

ELECTRICAL NAVIGATION.

The very first application of the electric motor was for the propulsion of a boat. In the year 1839 Jacobi operated an electric boat on the Neva River, at St. Petersburg, with great success. The use of electricity for boat propulsion, however, has languished and only within a few years past has been taken up at all seriously. The result of the work done in this direction lately is the production of pleasure craft of small size in considerable numbers and, curiously enough, of a variety of boat which could not be operated possibly by any other known form of motive power—the submarine torpedo boat.

It seems that the subject has hardly been exhausted. The advantages of electric propulsion for boats, especially for passenger boats, are certainly very great and are worth more study than has been given them by those commercially interested in navigation. The electric boat enjoys many of the same advantages and is hampered by many of the same disadvantages that are experienced by the electric automobile. Its power is clean, noiseless, safe and economical. Its radius of navigation, however, is small, and is limited by the storage-battery capacity which may be carried aboard, thus making electric boats suitable only for comparatively short runs within the immediate neighborhood of the charging station. But precisely such conditions are presented by a very important branch of navigation—the ferry service. In the waters of Greater New York alone there is maintained a total tonnage of ferryboats which is surprising. All of these boats have comparatively short runs and lie in their slips for periods of time between runs, in many cases almost as long as are the runs themselves. This situation presents practically ideal conditions for electric navigation. Outside of all the other advantages of electric ferryboats it would be possible to make them of a flush-deck type, with no machinery or smoke pipes projecting above the general surface level, and thus secure a considerable economy of space.

Only a few days ago a new submarine torpedo craft was added to the United States Navy, this being one of six now either completed or under construction. Vessels of this type have been made possible solely through the use of electric motors for their propulsion, and the submarine craft of other nations, notably France, are designed along much the same general lines. Within recent years electric launches and pleasure boats have become a well-recognized feature of pleasure parks and resorts of one sort or another, and have proven themselves excellent additions to the equipment of parks operated by street railway companies. It is to be hoped that the problem of electric navigation, especially as it concerns passenger boats making short trips, may be taken up and studied with that seriousness which the promise of what has already been accomplished appears to give the subject.

The demonstration of the success of electrical navigation on a fairly large scale would open up a new field for the profitable extension of electrical applications.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LVII.

BY W. ELWELL GOLDSBOROUGH.

In this position it is seen that, at the instant the current reaches its maximum value, the coils are in such a position that they set up a magnetic flux opposed to the field flux, that is, one which tends to follow the same path as the field flux, but in an opposite direction; consequently, the armature reaction tends to diminish in this case the total flux enclosed by the

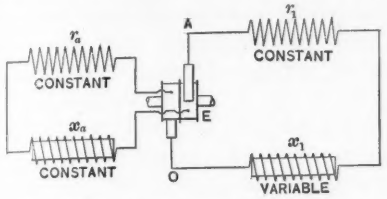


FIG. 140.—ALTERNATING MECHANISMS.

field coil below its no load value. When the alternator is short-circuited, it has been shown that the current in the armature will lag approximately 90° behind the total internal electro-motive force. At the instant that the current reaches its maximum value, the teeth will, therefore, be displaced by an angular distance of 90° from the position they occupy when the total internal electro-motive force is a maximum. Accordingly, when the current lags 90° behind the total internal electro-motive force, it reaches its maximum value when the teeth are in the position shown in Fig. 139. In this position, the magneto-motive force, due to the armature current, directly opposes the magneto-motive force, due to the field current; consequently, the total flux enclosed by the field coil is reduced in proportion to the magnetizing power of the armature coils.

SINGLE-PHASE ALTERNATORS UNDER A VARIABLE INDUCTIVE LOAD.

It is very rare, indeed, that an alternator is operated commercially under a strictly non-inductive load; in by far the larger number of instances, the load is inductive. We will, therefore, proceed with the discussion of the conditions diagrammatically shown in Fig. 140, in which a single-phase alternator having constant armature resistance and inductance is impressed upon a circuit having a constant resistance r_1, and a variable inductive reactance x_1. We may assume, initially, that x_1 equals zero. Such an assumption will give us a vector diagram like that of Fig. 133, since, when x_1 is zero, the elements present are merely those incident to the working of an alternator under non-inductive load. Suppose, now, we introduce inductance into the external circuit; that is, give x_1 an appreciable fixed value. The value of the current now flowing in the circuit is expressed by the equation

$$I = \frac{E_0}{\sqrt{(r_a + r_1)^2 + (x_a + x_1)^2}} \quad (54)$$

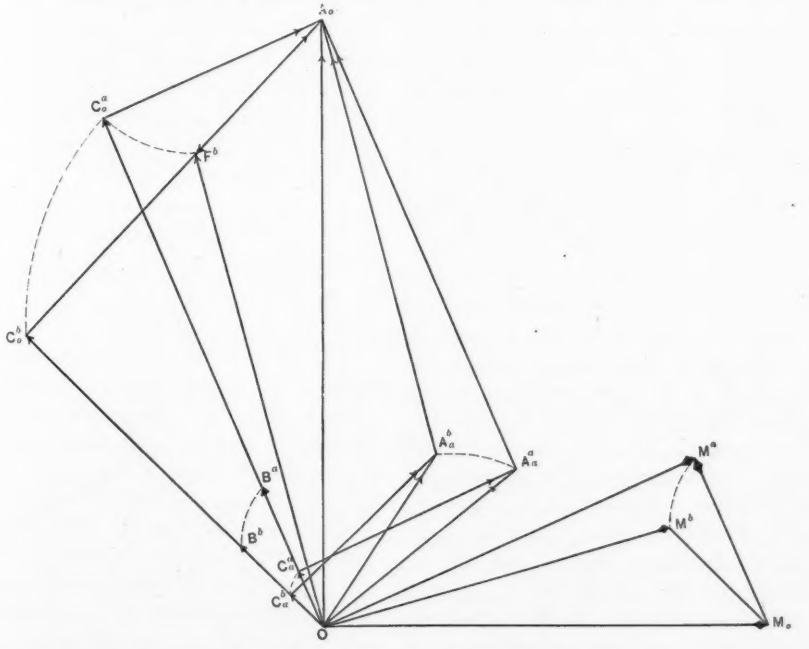


FIG. 141.—ALTERNATING MECHANISMS.

and it will lag behind the total internal electro-motive force OA_0 by the angle

$$\phi_0 = \tan^{-1} \frac{x_a + x_1}{r_a + r_1} \quad (55)$$

Referring now to Fig. 141, the vector positions in which, designated by the letter (*a*), are the same as those shown in Fig. 133, we will trace what takes place with the introduction of the inductance x_1 into the receiver circuit. Since, by equation (54),

$$E_0 = I\sqrt{(r_a + r_1)^2 + (x_a + x_1)^2}$$

the total resistance and reactance electro-motive-force triangle A_0C_0O, erected on the vector OA_0, will always remain a right angle. With the introduction of x_1, the heel C_0^a of this triangle will move to some new position, as C_0^b. The current vector OB^a, which is always in phase with OC_0, will take up the new position OB^b. Moreover, since the total resistance electro-motive force will always be equal to $I(r_a + r_1)$, in which $(r_a + r_1)$ is a constant, the length of the current vector must be decreased proportionally to the decrease in the resistance electro-motive-force vector OC_0, and since C_0 traces out a locus that is the arc of a circle, the current vector head B will also trace out a locus that is an arc of a circle.

To determine the impedance drop through the armature under these conditions, we lay off OC_a^b in phase with OB^b, and equal to $OC_a^b = I^b r_a$, and at C_a^b erect the perpendicular $C_a^bA_a^b$ equal to $C_a^bA_a^b = I^b x_1^b$. Accordingly, OA_a^b equals the new impedance drop in the armature.

Now,

$$E_a = I\sqrt{r_a^2 + x_a^2} \quad (54)$$

therefore any change in the value of the current will produce a proportional change in the value of the impedance drop through the armature; consequently, as the impedance vector decreases in value, its vector head will trace out a curve $A_a^aA_a^b$, which is the arc of a circle.

The electro-motive force at the collector rings must be equal to the vector difference of the vectors OA_0 and OA_a^b; it is, therefore, equal to $A_a^bA_0$.

Platinum in British Columbia.

It is reported from Vancouver that considerable quantities of platinum have been found in the gold-mining districts of British Columbia. The presence of this valuable metal in any quantity was first discovered by the American consul at Vancouver in some specimens of gold which had been brought to him to be refined. In many of the mining districts of British Columbia and the Yukon Territory, he asserts, large amounts of platinum and kindred metals must have been thrown away by miners who do not know platinum when they see it. With the present high price of platinum, it is thought that it will pay prospectors to be on the look out for the metal, which doubtless exists in considerable quantities in British Columbia.

Science Brevities

Polarization of Magnesium—We quote from an English contemporary: The properties of an aluminum anode have been utilized for the rectification of alternating currents, and A. Campetti has studied the polarization of magnesium with a view to a similar utilization. He uses a platinum cathode and a solution of caustic soda. He finds that the intensity of the current passing through the cell is very small until a difference of potential of 75 volts is applied, when there is a rapid evolution of gas and a strong current. When the platinum is made anode the current is about thirty times as strong. It appears that ten or fifteen per cent of the energy transmitted through the cell is used up in overcoming the resistance at the boundary between the electrodes and the liquid.

Frequency Measurements—Several new methods for measuring the frequencies of rapidly alternating currents have been devised by K. E. F. Schmidt. Mr. Fournier D'Albe quotes an abstract from the *Annalen der Physik*. In one of these a telephone is made to produce stationary sound waves in a glass tube, and two positions of minimum resonance are determined by means of a piston. The telephone is excited by the current to be studied, and the position of the piston, together with the known velocity of the sound in air, suffice to determine the frequency sought. The author has also successfully employed Kundt's dust figures for the same purpose. Both methods are only suitable for frequencies which are considerably higher than those ordinarily used. For ordinary frequencies the author employs an incandescent lamp fed by the current under investigation. This is photographed by a camera attached to a pendulum, and the negatives show alternate bright and dull stripes in accordance with the maxima and minima of the current traversing the lamp. An interesting application of this principle is obtained by simultaneously photographing two lamps in this manner, one of which has a difference of phase with respect to the other, as in the primary and secondary circuit of a transformer. The difference of phase expresses itself in a displacement of the stripes with respect to each other.

Dielectric Constant of Paraffins—W. G. Hormell has obtained, by means of a modified form of Blondlot oscillator, the dielectric constants of four commercially different paraffins for electric waves of forty, sixty and eighty cm. The *Electrician* states that the results show that the dielectric constant of a given paraffin increases with the density of the paraffin. It increases rapidly from a temperature twenty degrees above the melting point to a temperature thirty degrees below the melting point. Among different paraffins the dielectric constant increases as the melting point of the paraffin increases. The constant also increases with the rapidity of the electrical oscillations, and is greater for short light waves than it is for short electrical waves. The author finds that Cauchy's formulæ as a means of obtaining the index of refraction for infinitely long waves does not meet the experimental facts. Incidentally, the author determined the velocity of propagation of electric waves eighty centimetres in length along magnetic and non-magnetic wires of different diameters. He found that for reversals as high as 800,000,000 per second the velocity of propagation is the same, thus showing that the magnetic properties of iron are not able to follow such rapid changes. The effective field around the Lecher wires, as far as it can be detected by means of an argon tube, does not extend more than three cm. from the wires, and the effect on the half wave within this region varies approximately inversely as the square of the distance from the wires.

Point Discharge Figures—De Heen has described the following simple experiment. A plate of rosin is charged with electricity and then held for a moment over a number of Bunsen burner flames, grouped symmetrically. When the plate is now dusted over with flour of sulphur, the sulphur adheres only in sharp, well defined lines, forming polygons, whose centres correspond to the flames. De Heen speaks of *tourbillons de l'ether*. But we do not understand the phenomenon better by resorting to the ether. Following up these experiments, according to an abstract in *Engineering*, Rudolph H. Weber, of Heidelberg, states in the *Annalen der Physik*, that the flames can conveniently be replaced by metallic wires fitted with sharp points. He charges his plates by means of a metallic comb and discharges them again with the aid of these needles, which he arranges about fifteen centimetres apart. The charge may be positive or negative; if powder mixtures of different colors are applied, only the color of the polygon outlines will vary with the sign of the electrification. The lines are sharp and straight, the corners somewhat rounded off; the powder will adhere to the spots where the plate has remained charged. The experiments can further be modified. The collector of an electric machine is covered with white silk, and a needle is approached while the machine is worked. We notice the well-known brush discharge from the point, and the discharge cone is marked on the silk as a luminous circle. If two needles are used, a black line appears between the two luminous areas where they overlap; this line becomes sharper as the needles are withdrawn to greater distances. When several needles are applied, we get the polygons spoken of. When we interpose sensitized paper between the metallic collector and its silk covering, the phenomenon will photograph itself. If we hold insulators between the points and the collector, the shadows of these insulators will for some moments remain visible on the luminous areas; but they disappear gradually. The discharge of the collectors seems to be due to material particles. For when we blow at the brush discharge cone through a piece of glass tubing, the respective polygon line becomes bent as if yielding to the air pressure. But we have no real explanation, though various apparent analogies can be quoted. When chemical reactions proceed from a number of symmetrically grouped points, similar curves, the lines of chemical inactivity of E. Lecher and of E. J. Mills, are observed as boundary lines of the various areas of activity.

Electroplating.

Experiments have lately been carried out by Mr. W. Pfanhauser, Jr., in order to determine the dispersion of the lines of current in electrolytes. The author has found that in electroplating objects of irregular shape the current lines tend to concentrate at the points of the cathode nearest to the anode, just as the lines of force in the magnetic field of a horseshoe magnet are most concentrated at the points of the poles which are nearest together. The lines of current are more evenly spread over the whole surface of the object with some electrolytes than with others, and the author proposes the theory that the spreading is proportional to the difference between the discharge potentials of the cations of the "conducting salt" (usually K, Na, or H) and of the metal which is to be deposited.

The gold mines of Mysore, India, are worked by American electrical devices, the power being from the melting Himalayan snow.

The Protection of Lines and Apparatus from Electrostatic Strains.

A Lecture Before the American Institute of Electrical Engineers.

THE one hundred and sixty-first meeting of the American Institute of Electrical Engineers was held in one of the lecture rooms of the Havemeyer Building of Columbia University, New York city, on the evening of Friday, February 14, 1902. The evening was given over to the reading of a paper by Mr. Percy H. Thomas, part of which appears below. The subject of Mr. Thomas's paper was the effect of static stresses on high-tension circuits and apparatus and the protection of these by suitable means against damage from accumulated high potentials. At the conclusion of the paper it was briefly discussed by Messrs. Charles F. Scott, Francis O. Blackwell, George F. Sever, Philippo Torchio, the president, and Mr. H. W. Fisher. The latter gave some very interesting data of experiments undertaken by him to standardize the spark-gap as a means for measuring high potentials.

The meeting lasted until a late hour, and it was one of the best attended that the Institute has had recently. The paper of the evening was brilliantly illustrated by demonstrations, and the author exhibited a mechanical model of an electrical circuit of extraordinary beauty and ingenuity.

The next meeting of the Institute will be held at 12 West Thirty-first street, New York, on Friday, February 28, at 8.15 P. M. The general subject of the meeting will be "Electrochemistry and Electrometallurgy."

The following papers will be presented: (1) "The Electrochemical Industries," by Dr. Samuel Sheldon, of Brooklyn. (2) "The Electric Furnace in Industrial Chemistry," by Mr. Charles B. Jacobs, of New York. (3) "Electrolytic Recovery of Copper from Low-Grade Ores," by Dr. Nathaniel S. Keith, of New York. (4) "Colloids," by Mr. W. R. Whitney, of Boston. (5) "Liquid Potentiometer; Determining Electrolytic Resistance with Direct-Current Instruments." (6) "Point of Cut-off in a Battery Discharge." (7) "Electrolytic Conduction without Electrodes," by Mr. Carl Hering, of Philadelphia. (8) "Methods of Experimentation in Electrochemistry," by Mr. Charles S. Bradley, of New York.

As the above papers will be presented in abstract only, members who are especially interested in the subject are requested to send for advance copies, which will also be distributed at the meeting.

Chairman Rice, of the Committee on Papers, and Chairman Mullin, of the Committee on Transportation and Accommodation, after a visit to Great Barrington, Mass., recommended, and it has been decided, that the date of the annual convention to be held in that town be changed to June 17, 18, 19 and 20, a special train to leave New York on June 16. This was deemed necessary in order to assure ample accommodation, as it is believed that the preparations being made will lead to a much larger attendance than was originally anticipated. All the available space in the "Berkshire Inn" and all the rooms in the "Barrington" will be reserved for the occasion.

STATIC STRAINS IN HIGH-TENSION CIRCUITS AND THE PROTECTION OF APPARATUS.

BY PERCY H. THOMAS.

It is the purpose of the present paper to discuss the so-called "static effects" in high-tension circuits, especial attention being given to the disturbances produced by lightning, switching, grounding and the like. Some discussions of particular phases of the principles involved have appeared from time to time, but so far as has come to the attention of the author, no comprehensive treatment of the subject of a non-mathematical character has so far appeared. On this account a general view of the question without mathematical complication will probably prove of interest to superintendents and station managers as well as to electrical engineers. Necessarily much of the matter in the paper will not be new, but it will be found that the old principles when applied to commercial circuits yield quite novel and important results.

It is scarcely necessary to state that static strains, though not, perhaps, particularly destructive of themselves, may indirectly cause the loss or temporary disabling of expensive and important apparatus, and more is involved than the loss of the apparatus. One of the principal aims, if not the chief aim of the superintendent of a modern electric transmission system, for the accomplishment of which he will make great sacrifices, is to keep his service continuous. Static disturbances in such systems, when not properly controlled, are a constant menace to the continuity of the service. The prominence of static effects is one of the chief distinguishing characteristics of high-tension operation. The importance of "static" is not emphasized solely on theoretical grounds. Plants in actual operation have suffered both damage to apparatus and loss of prestige on account of insufficient static protection.

The paper will be divided into two parts:

I. Nature, Causes and Effects of "Static" Disturbances; and

II. The Protection of Apparatus and the "Static Interrupter."

PART I.—NATURE, CAUSES AND EFFECTS OF STATIC DISTURBANCES.

INTRODUCTORY.

The term "static" is certainly a misnomer, as the most prominent characteristic of the phenomena thus designated is the abrupt and violent nature of their discharges of electricity. However, this group of phenomena is so clearly defined and is so generally recognized by this name that in the absence of a better term of general acceptance its use will be continued. A new term, however, is very greatly to be desired, and as the phenomena described are essentially those of wave motion, the author recommends the word "undic" as a substitute for "static."

For the present discussion "static" (or "undic") will be taken to include those changes of potential and waves of current of an abrupt nature which result from the transfer of the electrostatic charges of a system from point to point. Such actions are not directly produced nor controlled by the generator. I say "not directly," for, of course, practically all electrical phenomena in a circuit, except those due to lightning, are produced at least indirectly by the generator.

Every electric circuit may be viewed in two ways. It may be regarded (as in dealing with the transmission of energy) as a closed circuit containing resistance and inductance and carrying a certain current produced by a certain electro-motive force,

or it may be regarded (as in dealing with static) as a large insulated "conductor" (as the term is used in treatises on static electricity) of peculiar form. That is, the circuit performs a double function. It transfers useful energy and at the same time acts as an electric condenser. The first aspect, being the one of greatest practical importance, is the one almost universally considered. However, even in this case, with long high-tension lines, it has been found necessary to give some attention to the e. s. (electrostatic) capacity of the circuit taken as an insulated "conductor." The second aspect of the circuit is the one to be here considered, and though of less importance than the first it still deserves careful consideration on account of the serious difficulties static may cause in commercial work. As a matter of fact, since the electric circuit when operating is at the same time both a closed circuit carrying current and a charged insulated "conductor," the actual resultant condition of the system is a combination of these two states.

There are some points of difference, however, between the commercial electric circuit and the insulated "conductors" commonly used in the laboratory demonstrations of static electricity. In the first place the commercial circuit is very much the larger and is extended over greater distances, so that a sensible time is required for an electric impulse to pass from one end to the other. Consequently two points on the same conductor may be momentarily at very different potentials. In the second place the amount of energy stored in the e. s. capacity of the commercial circuit is very much larger than that in the "conductors" of laboratory experiments. It should be noted that these points of differences are both differences of degree, not of kind.

It will be well at the outset to summarize briefly the most characteristic of the laws of static. These are all well known and of very general applicability, *viz.:*

LAWS OF STATIC.

I. A static discharge (which is merely a very sudden rush of electricity) encountering a choke coil in its path, experiences momentarily great opposition, *i. e.*, the electricity is temporarily held back by the inductance of the coil so that if the rush of electricity be of large volume and sufficiently sudden a very great electro-motive force (neglecting losses of energy) will be exerted on the choke coil. This high electro-motive force is but momentary, however, as the choke coil after the first instant allows the electricity to pass at an accelerating rate which soon relieves the pressure. The high momentary pressure at the front of the choke coil causes a tendency for the charge to seek other paths. Such a phenomenon would be called "side flash," and is one of the considerations which led to the use of choke coils with lightning arresters. Lightning arrester choke coils are so placed that any static disturbance on the line must pass the choke coil to reach the apparatus which is being protected and the arresters are placed on the line side of the choke coils where the tendency to side flash is strongest.

As there is a tendency to side flash toward other objects there must evidently also be a tendency to short-circuit the choke coil itself. Such short-circuits are by no means unusual when coils not designed to stand them are exposed to static discharges.

II. All conducting bodies have e. s. capacity or, in other words, are to a greater or less degree condensers. Whenever a conductor is at a potential different from a neighboring conductor a charge of electricity appears in its surface principally on the side toward the other body. The amount of this charge equals the product of the e. s. capacity and the potential between the bodies. At the same time an exactly equal charge appears on the second body. A conductor may have capacity to two or more adjacent conductors at the same time; in this case its resultant charge is the sum of the separate charges.

The fact that a certain quantity of electricity, great or small, is required to charge any conductor to any definite potential is very important in its bearings on long-distance lines. Suppose, for instance, that a piece of apparatus at one end of a transmission line is to be raised to a certain potential by a sudden application of voltage at the other end. A sensible time will elapse before the necessary charge for the apparatus can reach the end of the long line. Consequently the potential of the apparatus will not rise at the same instant as an applied electro-motive force, but will remain unchanged until charge actually reaches it. In other words, the potential of a condenser can not rise until the charge necessary to produce this rise has entered it.

The large current required to charge the line wires of an extensive high-tension system is well known. All switches, transformers, instruments and other apparatus actually connected to the high-tension circuit also require charge, though, of course, much less.

The line wires have e. s. capacity both to the earth and to one another. The several charges corresponding to those different capacities, though superposed on the wave, act independently of one another and must be so studied. Similarly with apparatus connected to the lines, not only will there be e. s. capacity in the high-tension parts to ground and low-tension parts, but also between different parts of the high-tension windings themselves.

III. When a current is flowing through a circuit containing inductance, energy is stored in its magnetic field. The amount of this energy equals one-half the product of the inductance and the square of the current. This energy was obtained from the circuit when the current was started and when the electro-motive force producing the current is removed, this stored energy must be discharged back into the circuit before the current can stop. If the circuit be suddenly opened a very high potential will be developed to keep the current flowing until this energy is fully discharged. Such is the case of the well-known rise of potential which results from suddenly opening the field circuit of a large generator. The direction of this "extra" electro-motive force when the circuit is opened is always such as to continue the current flow.

Energy in a magnetic field is just as truly stored energy as that in the moving bullet, the stretched spring or the raised weight. It may be adapted to useful purposes. For example, the energy stored in the magnetism in the core of an induction coil by the primary current is discharged into the secondary to produce the high-tension spark.

An idea of the amount of this energy in actual cases may be obtained from the following: One ampere flowing through a coil w with an inductance of one henry (equivalent to 377 ohms at 7,200 alts.) stores 1/2 volt-ampere sec. = 1/2 watt-second = 1/2 joule = 0.367 foot-pound.

The very sudden rushes of static electricity are no exception to this law; they produce magnetism and store energy which must be discharged into the circuit again before the currents can cease. This principle will be found to lead to important results.

Also, when a condenser is charged energy is stored. This energy will be restored to the circuit again when the condenser is discharged. The amount of this energy is one-half the product of its e. s. capacity and the square of the voltage.

A condenser of one microfarad capacity charged to 1,000 volts potential stores

one-half a watt-sec. = 1/2 joule = 0.367 foot-pound.*

The energy of an electric current may thus be stored in two ways, either in a magnetic field produced by a current, or by the storing of the electricity itself. In its former state the energy may be regarded as kinetic and in the latter as potential.

ELECTRIC CIRCUIT AS AN INSULATED CONDUCTOR.

It has been stated that an electric circuit may be considered as an insulated conductor of a peculiar form. It is rather an aggregation of conductors of various forms. In general a high-tension circuit consists of the following parts:

(*a*) High-tension windings or transformers, raising and lowering.

(*b*) Transmission wires.

(*c*) High-tension switches, instruments, lightning arresters, station wiring and similar auxiliary apparatus.

(*a*) The high-tension transformer windings are in the form of coils, and are therefore from the static point of view choke coils. On account of the very large number of turns their choking power is very great (choking is general, being proportional to the square of the numbers of turns). The high-tension windings have e. s. capacity also, as they lie close to the low-tension windings and to the core, that is, the high-tension winding will have static charges on the surface opposite the low-tension winding and opposite the core. There is as well capacity between turns and between coils of the high-tension windings. The e. s. capacity of these transformer coils is of a rather complicated nature, for it is distributed along at different points on the winding, and is not concentrated at one point as in an ordinary condenser. Therefore, the charge for the different portions of the windings must pass through different lengths of wire and different amounts of inductance and resistance. The same is true of both raising and lowering transformers.

(*b*) The transmission wires have e. s. capacity with one another and with the earth, so there are two charges superposed on each wire—each of which may act independently of the others. This capacity, though comparatively small for short lengths of wire, is, as a whole, great on account of the great length of the lines. These wires have inductance also like the capacity; small for short lengths, but quite considerable when the line is taken as a whole.

On the line wires, as in the high-tension transformer windings, the e. s. capacity and inductance are distributed, so that when voltage is applied to the line different points receive charging current at different instants of time, since the charge for various points must flow through different lengths of line. In fact, the transmission wires (the same may be said of high-tension transformer winding) may be considered as a succession of choke coils and condensers in series, each very small, but very great in number, as shown in Fig. 1.

In addition to the e. s. capacity of the

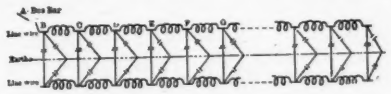


FIG. 1.—DIAGRAM ILLUSTRATING INDUCTANCE AND CAPACITY OF A LONG SINGLE-PHASE TRANSMISSION LINE.

line wires there is a certain amount of capacity on each insulator. The amount is very small and may be considered a part of the line capacity.

(*c*) Switches, instruments, lightning arresters, station wiring and similar auxiliary apparatus have a certain amount of e. s. capacity to surrounding objects, but not usually as much as the high-tension windings of transformers. This part of the system has also comparatively little inductance and needs no further discussion here.

In addition to e. s. capacity and inductance all parts of the high-tension system have more or less ohmic resistance. The effect of this resistance is to retard the current (static or normal) in whatever direction it flows, and to change part of the electric energy into heat.

A certain amount of current leaks from the line at insulators and at all points where insulating material touches the circuit, since no insulation is perfect. Even the air conducts away some charge when the voltage is extremely high. Taken altogether the result of these leakages is small under normal conditions and may be neglected in this discussion.

Every point of a high-tension circuit at any instant has a perfectly definite potential, which is in general different from the potential of other parts of the circuit and of adjacent objects. Consequently each point has at each instant a definite static charge, often different from that of other points. As (with alternating currents) the potential of each point is varying from instant to instant these charges are continually changing and the changing charges cause a current in the circuit properly called charging current. Neither this charging current nor the static charges have any connection with the useful current, except as the latter may influence the static potential of some point of the circuit. The total current in the circuit at any instant is the sum of the work current and charging current if they are in the same direction, or their difference if they are in opposite directions.

When the potentials of all points of a circuit are determined directly by the electro-motive force of the generator, *i. e.*, during normal operation, all changes of potential are slow (compared with static changes of voltage) and allow sufficient time for the necessary changes in the static charges at various points to be accomplished without serious opposition from the inductance of the circuit. Such changes of potential and charges as these, however, are not the subject of this paper. Its principal object is the discussion of changes of potential of a more abrupt nature which are not directly produced by the electro-motive force of the generator; the latter may cause violent and sudden alterations of the static charges and dangerous local potential strains. However, before taking up the more complicated case of the abrupt changes, it will be best to consider a little more fully the distribution of potential and charge in some of the simpler cases of normal running, *viz.:*

Static Charges on a Symmetrical Single-phase Transmission Line Open-Circuited at the End and Charged by a Direct-Current Generator—In this case both lines have the same e. s. capacity to the earth. There is also capacity between the line wires. On the positive line is a positive charge composed of two parts, one due to its capacity to earth and the other to its capacity to the other wire; similarly on the negative wire is an equal negative charge composed of two parts. These charges remain constant as long as the electro-motive force of the generator is constant.

If, however, the generator is an alternator the charges change from positive to negative with the voltage remaining equal on the two wires at times. This interchange of charges requires a flow of cur-

*The transmission lines of a system like the Bay Counties Power Co. of California with lines 150 miles long, have a capacity of about 3 microfarads. Operating at 40,000 volts this will have $1/2 \times (3 \times 10^{-6}) (40{,}000 \times \sqrt{2})^2 = 4{,}800$ watt-secs. = 4,800 joules, equals 3,500 foot-pounds of energy stored in its e. s. capacity when fully charged. The charging current is 45 amperes at 40,000 volts, 7,200 alternations. Therefore the rate of supply of energy to the line from the generator and absorption from the line by the generator is $45 \times 40{,}000 \times 2 \times \frac{1}{\pi} =$ 1,150,000 watts-sec. per sec., = 1,150,000 joules per sec., equals 843,000 foot-pounds per sec. The generator supplies current continuously to the line for 1/2 alternation and then receives it back again for the next half alternation. Therefore the energy delivered or received in a half alternation is the energy stored in the capacity of the line $= \frac{45 \times 40{,}000 \times 2}{\pi \times 60 \times 4} = 4{,}800$ watt-secs. = 4,800 joules = 3,500 foot-pounds, as before.

rent from line to line through the generator.

When the same line is loaded at the farther end no material change is produced in the line charges. Since different parts of the high-tension winding of the motor or transformer or other apparatus constituting the load are at potentials varying all the way from one-half line voltage positive to one-half line voltage negative, the charges on these points will vary in a similar manner. These charges are supplied from the generator through the line. The charges for the inner parts of the winding of the load apparatus must flow through the outer parts of the winding as well as through the line.

Same Line with One Leg Grounded—Since direct current is practically never used in high-tension work it will be omitted from further discussion here. The case of a grounded line is of importance, not as a practical operating condition, but on account of the harmful results which may follow accidental grounds. The potential of one-line wire becomes the same as that of the earth, while that of the other is full-line voltage, that is, double its value with circuit ungrounded. The potential between the wires being maintained by the generator remains unchanged. Of the two component parts constituting the charge on the ungrounded wire the part due to the e. s. capacity between the wires is undisturbed by the grounding since the voltage between wires is unchanged, but the part due to the capacity to earth is doubled since the potential of the line above the earth is doubled. On the grounded line the part of the charge due to the e. s. capacity between wires is unchanged—the part of charge due to capacity to earth becomes zero, since the potential to earth is zero. The charge which appears on the earth opposite the ungrounded wire and which is equal in amount to the part of that line's charge that is due to capacity with the earth, being produced by the generator, must flow to earth at the point where the circuit is grounded. On a large system the e. s. capacity of the lines would be sufficient to make this current quite large. In such a case the current may burn off the line wire at the grounded point if the contact with the earth is imperfect. This fact has a very direct bearing on the question as to whether it is possible to operate a large high-tension system with one wire accidently grounded.

System with Neutral Point Grounded—In a symmetrically arranged ungrounded system either single phase or polyphase, a neutral point may be defined as any point which is at the earth's potential. There may be more than one neutral point in a circuit, as shown in Fig. 2, where *a b c d* are neutral points.

Since the neutral point is at the earth's potential, grounding this point makes no difference in the potential or charge of any point of the circuit and no current flows over the grounding wire. If the circuit becomes unbalanced, for example, by a high-resistance ground on one wire, there is a tendency for the neutral point to take a potential different from that of the earth, and a current will then flow over the grounding wire which will be sufficient to keep the neutral point at earth's potential. If there be a dead ground on one wire the earth connection at the neutral point completes a short-circuit. If the neutral point is not grounded when the system becomes unbalanced one or more lines will take a potential higher above the earth than in the balanced condition and the other line or lines a potential

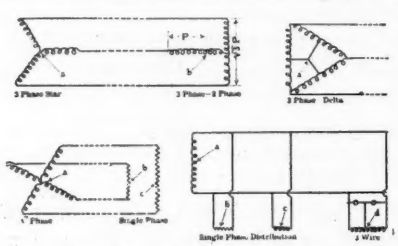


FIG. 2.—NEUTRAL POINTS.

lower than before. Therefore, comparing the two methods of operation with the neutral grounded, if a "dead" ground is made on any line wire a short-circuit is produced through the ground connection at the neutral point; with the neutral ungrounded a ground on a line wire means twice the previous potential between line and ground on one or more wires though no short-circuit is produced. The advantage of a grounded neutral is the preventing of increased potential over the earth in case of an accidental ground, its disadvantage is the fact that one such accidental ground instead of two causes a short-circuit.

We may now consider some of the abrupt changes of potential not directly produced by the generator.

1. Connecting "Dead" Transformer to Live Line—Fig. 3 represents the portion of a high-tension transformer coil connected to the line terminal. The circles indicate wires. The coil may have one or more turns per layer, The numbers on the circles indicate the order in which the current passes through the turns of the winding. The low-tension winding lies adjacent to the high-tension and the small condensers, *a b c d*, etc., shown dotted, indicate the e. s. capacity to the corresponding wires of the adjacent low-tension coils.

Before either terminal of the transformer is connected to the line all parts of the high-tension winding are at earth's potential. As the first line switch is being closed at S there is no change in the potential of the transformer winding until a spark passes between the switch jaws. Then instantly the potential of the transformer terminal is raised to the potential of this line wire. The rest of the high-tension transformer winding also takes the potential of this line wire as soon as (but not sooner than) the necessary charge can reach *b - c - d - e*, etc. Now, the charges for *b - c - d - e*, etc., must flow through a considerable amount of inductance, which will require a length of time which is very short but still sensible. It is clear that during this short but definite period, after the terminal has reached its full potential and before there has been sufficient time for charge to reach the inner layers, for example, *f* and *g*, etc., a difference of potential exists between the outer and inner layers of the winding which is equal to the full electro-motive force of the line wire above the earth. If the insulation of the winding is too weak or the line potential is very high this momentary difference of potential will cause a spark to pass over the surface of the coil or through its insulation. This spark contains, of course, a very small amount of electricity, for as soon as the wires, etc., *f, g,* are charged up to the line potential, the voltage between the inner and outer layers vanishes. The only result is the almost harmless passage of a nearly invisible spark.

Very soon after the closing of the first line switch the whole transformer winding will have assumed the potential of the first line wire, that is, just before the closing of the second line switch the second transformer terminal is at the potential of the first line. As the second switch is closed a spark passes and the potential of the second terminal of the transformer which has, up to the instant, been at the potential of the first line is suddenly changed to that of the second line—a very abrupt change. Then, as before, during the period required for the necessary change to penetrate to the inner turns a very high-potential difference is impressed on the outer portion of the coil. The momentary strain on the insulation of the coil is much greater when the second switch is closed than the first, for the first transformer terminal experienced an abrupt change only from earth's potential to line potential, while the second was changed

from the potential of one line to that of the other line, which is nearly double the potential from the ground.

There is another very important difference between the effects of closing the first and second switches in connecting a "dead" transformer to a live line. In the case of closing the first, as already stated, if the momentary strains break down the insulation, and only sufficient current flows through this break to charge up the inner layers of the transformer coil, this is a very small quantity and can do comparatively little injury to the coil, especially if it be oil-insulated. In the second case the amount of current passing in the static spark is not very materially greater than in the first case. But when the insulation beween turns is momentarily broken down by this small spark there flows through the break a certain amount of current due to the electro-motive force impressed on each turn of the coil. Although the static spark of itself would be but momentary, yet the current supported by the impressed or "normal" electro-motive force of the circuit may be able to hold the arc and continue indefinitely, destroying the whole coil if not interrupted. I say *may* be able to hold an arc, for such an arc may or may not be held, according to the circumstances of the case. If the static spark passes when the normal electro-motive force is nearly zero, or if the transformer be not able to supply much current in short-circuited turns, etc., then the chance that a permanent arc will be established is small. Sparks or flashes have actually been observed in the winding of high-tension transformers at the time of lightning discharges, showing actual temporary holding of an arc.

The factors which determine the minimum number of layers upon which excessive momentary potential will be impressed are, chiefly, the inductance and e. s. capacity of the transformer coils and the abruptness of the change of potential of the terminal on the closing of the switch. The former determines the rate at which the charge can penetrate the coil, and the latter determines the time during which charging current may be passing into the coil before the full potential is reached on the terminal. The more abrupt the spark and the greater the capacity and inductance of the coils, the fewer the number of layers which will become charged before full terminal potential is reached and the more severe will be the strain on insulation.

When switching is done on a high-tension generator or a motor or any apparatus containing coils, a strain is brought in the windings near the terminals in exactly the same way as with transformer coils. There is also, usually, this same tendency for normal voltage to cause an arc to follow any momentary break in the insulation.

It is evident that the danger from this sort of switching is greater and greater for higher and higher voltages—it is of little importance on low voltages. Actually, injury of a serious nature to apparatus from this source is very much less than would be at first expected for several reasons:

(*a*) Insulating materials will stand much higher voltages of a static nature than of a continuous nature, such as those derived from generators.

(*b*) The passing of a static spark alone is usually by no means a serious matter, and many circumstances may prevent a destructive arc from following the spark.

(*c*) It is only occasionally that the

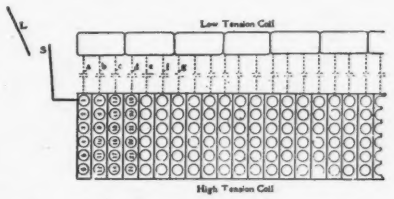


FIG. 3.—DIAGRAM ILLUSTRATING E. S. CAPACITY OF A HIGH-TENSION TRANSFORMER COIL AND CHARGING FROM A LIVE LINE.

combination of circumstances arises which gives the severest conditions.

It has been assumed thus far that the potential of the line wires is unaffected by the switching operations. If, however, the connecting of the transformer to the line momentarily lowers the line potential at the switch, as will often occur, the abruptness of the static strain, and therefore its severity, will be reduced.

This discussion which has been applied to switching on a transformer is applicable when any coil is subjected to an abrupt change of potential in any part. For example, when a dead transmission line is connected to a live transformer the potential of the transformer terminals will usually be suddenly lowered very considerably for the moment on account of the great excess of e. s. capacity in the line over the transformer coil. In this case the potential of the line which must be charged directly by the generator (and not from charge previously stored in the e. s. capacity of other lines) will rise very much more slowly since current must pass through considerable inductance in generator and transformers. Sudden short-circuits, grounds, discharges of lightning arresters and similar disturbances all produce static strains more or less severe according to circumstances.

FOURTH LAW OF STATIC.

Before continuing the consideration of other cases of serious static it will be best to consider one or two more fundamental cases:

IV. When a condenser discharges suddenly through an inductive circuit containing comparatively little resistance the current in the discharge path increases continuously until the condenser is completely discharged. At this time the current, in virtue of the magnetic field which it produces, stores nearly the full amount of the energy originally in the condenser, for there is little waste, as a resistance is assumed to be small.

But this current can not become zero until all its energy is discharged into the circuit, which in this case means into the condenser; therefore, the condenser is charged to its original voltage again, but this time in the opposite direction. At the instant all the energy is thus restored to the condenser (with reversed direction) the current is zero. But the condenser can not remain charged with the discharge path closed, and will discharge again, repeating the same phenomena; that is, the charge oscillates backward and forward through the discharge circuit. If the resistance is not zero a little energy is lost every time discharge occurs, so that each time the condenser is charged to a lower potential than the preceding time until the whole of the energy is finally transformed into heat. If now a condenser be charged through inductance continuously, energy will be stored in the magnetic field produced by the charging current (just as in the case of discharge) until the condenser has reached full potential. All this energy must be discharged into the condenser before the charging current can cease; that is, if there are no sensible resistance losses, the condenser will be charged momentarily to double potential. The condenser will then oscillate between double potential and zero until it finally settles down at the potential of the circuit from which it is charged, which occurs only as the oscillations are damped by the resistance of the circuit or by other losses. These phenomena may be made clearer by a mechanical analogy.

The first case of the discharging condenser is similar to that of a pendulum which has been drawn aside and released; it oscillates about its final position of rest until its energy is all expended in friction. The second case may be compared to a weight supported by a spring. If the weight be dropped it will descend beyond the point at which it is finally to come to rest, stretching the spring to twice its final extension. The weight will then be drawn up again above the point of equilibrium, oscillating backward and forward until its energy is dissipated by friction. The inertia of the weight corresponds to the inductance of the charging circuit and the spring corresponds to the capacity of the condenser.

(Concluded next week.)

The Common Battery System.

An Address Before the New York Electrical Society.

By J. J. Carty.

DURING the history of the New York Electrical Society, this is the second time which it has been my privilege to receive the society at this building and to exhibit and describe to it the central office telephone apparatus which it contains. It is almost exactly ten years ago that the society met in this building for the purpose of inspecting its telephone installation.

Ten years ago, as well as to-night, the Cortlandt street plant was of sufficient novelty, magnitude and merit to warrant a visit from such a distinguished society as yours. But within these ten years radical improvements have been made, changes have taken place, and an almost complete transformation has been effected. Therefore, before undertaking to sketch for your information an outline of the main features of the plant which it is my pleasure to exhibit to you to-night, it will be interesting and possibly instructive if I should first call your attention to some of the important advances in telephony which have been made in this country and in this city during the last ten years, all of which are embodied in what you are to see to-night, and when you view with the critical eye of experts that which is to be exhibited I am sure that your feeling will be that in the phenomenal advance in industrial affairs which has been made by Americans, that electrical developments are in the front rank, and that among these electrical developments the art of telephony has not lagged.

The opening of the present Cortlandt street central office was but the culmination of a series of works planned a number of years ago and but recently completed. The common battery system, of which the Cortlandt street office represents the highest type, was in New York first installed at Harlem more than three years ago. After a rigid demonstration of the system in that district, a great many improvements were decided upon, and the switchboards of all of our offices transformed from the old magneto system to the now standard common battery plan; and to show how rapidly improvements follow one upon another, I may say that before we had installed Cortlandt Street on the common battery system the Harlem office, in which it was first installed only three years ago, had outgrown its equipment, and a new building had been started for a greatly enlarged central office with improvements not known at the time the Harlem office of three years ago was installed.

At the time of its installation the first Cortlandt street switchboard represented all that was best in the telephonic art. The switchboard was large enough to accommodate 5,000 subscribers' lines and 600 trunk lines. It was inspected and studied by engineers from at home and abroad, and was regarded as so great an improvement over what had gone before that this society met to visit and inspect it in a body. But to-day there are those young in the business who laugh at our boasted improvements of ten years ago, and we, who were responsible for its installation, find it hard to justify to-day those plans about which we then boasted so much.

It is my hope and wish that we shall all live again to visit the Cortlandt street exchange at a time when the apparatus to be inspected to-night will be as antiquated as that which was the occasion of our first meeting in this building.

I shall say a word or two about some of the significant changes which have taken place during the last ten years in this building.

Ten years ago to operate each subscriber's transmitter it was necessary that two cells of Fuller battery be provided at each telephone station. To-day in the new switchboard we are operating on the common battery plan, no battery is required at the subscribers' station, all of the battery being concentrated at the central office and taking the form of large storage cells.

Ten years ago, in order to signal the central office, each station was provided with a small alternating-current generator operated by hand. To-day the generator is dispensed with at the subscribers' station, and the signaling is automatically performed when the subscriber takes the telephone from the hook.

Ten years ago, when the subscriber had finished talking, it was not only necessary that he should hang the telephone on the hook, but it was also necessary that he should give a brisk turn to the crank in order to send a clearing-out signal to the central office. To-day this is unnecessary; the act of the subscriber in hanging his telephone on the hook automatically lights a signal in the keyboard which notifies the operator to clear out.

Ten years ago, notwithstanding our numerous instructions in the telephone book and requests to subscribers that they should notify the operator to clear out by turning the generator crank when through talking, it was necessary for the operator, owing to the failure of the subscriber to remember these instructions, to listen in to see whether the subscribers had finished talking, and it was not only necessary to listen in but it was necessary for the operator to ask, "Are you through?" Unfortunately, owing to the strenuous conditions under which the then operator worked, she almost invariably reversed the order in which she conducted these operations, too often breaking in on the subscriber in the midst of his conversation asking, "Are you through?" and then listening afterward.

It will not be necessary to enter into details on this point in order to bring vividly to your mind the conditions which I have attempted to describe. At the present time, when two subscribers have finished talking, two lamps are lighted in the connecting cords in front of the operator in control of the connection. The lighting of these lamps means that both subscribers have hung their telephones on the hooks and have relinquished control of the line. Seeing the lamps lighted, the operator is not obliged to connect herself into the line and is not obliged to ask whether the subscribers are through, but knows of necessity that both subscribers have hung up, and that the only thing for her to do is to disconnect both lines.

It is owing to this fact that one of the greatest advantages of the common battery system is realized. A substantial improvement in the service arises from relieving the operator of the duty of supervising the connections by listening in. She can now supervise visually by glancing at the condition of the lamps to see whether they are lighted or not. The operator, thus relieved of the old-time supervision, can handle a much larger number of lines than formerly. Consequently, fewer operators are required, and furthermore, what is also important, fewer sections of switchboard are required. In the system of ten years ago, there were forty-four sections of switchboard in-

stalled upon the eighth story of this building. A new story has been added, but the floor space is identical in amount with that contained in the old story. At the present time 9,000 lines are placed in a room of the same area which formerly contained the 5,000-line switchboard, and the number of operators employed is not much greater than before. These constitute two of the important advantages of the common battery switchboard: The simplyfying of the labor of the central office, and the vast improvement in the character of the service rendered to the subscriber.

In addition to these, another improvement, by no means to be neglected, has been obtained. While formerly it was necessary to maintain two cells of Fuller battery at each subscriber's station, at the present time no battery at the subscriber's station is required, all of the current being provided from a few cells, although very much larger cells, at the central office. This relieves the subscriber from the annoyance formerly occasioned by the visits of the telephone battery men to make periodical renewals of the Fuller cells, which, in the case of busy subscribers, took place sometimes as often as once in two months.

The idea of a common battery switchboard was not new ten years ago. Many attempts to attain such an end were made, the principal idea being, however, to avoid the necessity of renewing batteries at subscribers' stations, no thought being given to the advantages accruing in the way of operating at the central office. When finally the result was obtained, it was found to the surprise of many that, while the doing away with the battery renewal at the subscriber's station was accomplished and while this was by no means an unimportant factor, nevertheless, when considered with reference to the improvement in the quality of service rendered, it was found to be of subordinate value.

When to-night you view this modern installation you will, no doubt, having in mind the Cortlandt street of ten years ago, be impressed with the fact that a vast amount of complication has been added to the system, and I think you will find it difficult to resist the idea that the tendency to complexity which will be perceived is to some extent unfortunate. But to this I can only say that the requirements of the modern telephone exchange have become more and more exacting and that a telephone exchange located, as Cortlandt street is, in the financial and business centre of this country has to be constructed with reference to the various complexities which there arise. There have to be considered those waves of excitement, those rushes of business, those financial panics, those concentrations of calls resulting from national celebrations, from explosions, accidents, etc., which, unfortunately, are so increasingly frequent in our modern civilization. To all of these influences the telephone exchange in general, and the New York telephone exchange in particular, is peculiarly subjected, and it is at these very times that the telephone is at its best. We should be derelict in our duty, therefore, if we did not plan our vast and complicated system so as to stand these sudden demands which no human foresight can avoid.

Even a harmless practical joke started on its way by some wag would, unless we provided sufficient reserve power, seriously embarrass the working of our system. Not long ago a joke akin to the Tom Collins joke of old was started in New York. A practical joker would tell his friend to call up Mr. Fish at — Broad on a matter of importance. The friend so informed would call up the number, only to be asked which Mr. Fish he wanted to talk to, because that number was at the Aquarium. For about a week this joke raged, and it took the services of a number of special operators to intercept calls for the Aquarium, and flash the joke in the pan, as it were, at the central office. Afterward, some minor jokers started a similar lot of calls for the Menagerie, at Central Park, and for the "Zoo," in the Bronx, sending their victims to the telephone to call up Mr. Wolf, Mr. Fox, etc.

Thousands of calls a day are received from subscribers who wish to know who is the nearest subscriber to a given number on a street named. It would be more troublesome to refuse these calls than to attend to them, so that provision for handling such contingencies must be made. In New York, the Saturday half-holiday has resulted in crowding into a very small space of time an enormous amount of business on Saturdays, and when Saturday half-holiday precedes a legal holiday the rush of business is intense.

In consequence of these conditions, our plans must be made on such a liberal scale that we can handle the business at the busiest periods, even when they occur at infrequent intervals. To meet these contingencies we have, in addition to installing a large amount of additional apparatus, provided a large number of special operators called monitors, whose sole duty is to relieve the subscribers' operators of the necessity of holding conversations with the subscribers and to take the request of the subscriber, whatever it may be, and see that adequate and polite attention is given to it. All of these conditions have been taken into account in making the plans for the installation which you will inspect to-night, and to some extent account for the complexities you will observe which were not present in the Cortlandt street of ten years ago.

But in making the comparison between the old system and the new, I wish to call your attention to other conditions which, when rightly viewed, will establish the fact that after all there has been a successful movement in the direction of simplicity. It should be borne in mind that in the old system there was required at each subscriber's station two cells of Fuller battery, which would, in an installation of the present magnitude, amount to 18,000 cells. All of these Fuller cells have been displaced by eleven cells of storage battery of the chloride type located at the central office and occupying only 110 square feet. If the 18,000 cells of Fuller battery were assembled at the central office and arranged on racks in the most economical way, it would occupy a very large space. In the old system a small alternating-current generator was required at each station. If these generators and batteries were massed at the central office they would together occupy a space almost equal to that occupied by the entire common-battery switchboard itself. The total weight of the present storage cells is only about 11,000 pounds, and that of the local batteries would amount to over 216,000 pounds.

During the last ten years many improvements have been made in underground telephone cables, but the main ideas of their original construction have been adhered to. Dry cables have taken the place of filled cables, paper has entirely displaced cotton, and the improvement has been in the direction of placing a larger number of pairs of wires in a given lead sheath. Cables of 200 pairs are now the rule where formerly only fifty pairs were used.

A vast amount of detail in construction and engineering has been worked out, and Mr. J. C. Rennard, our assistant chief engineer, who has carried on the practical engineering work of the New York installations, will describe to us many features of interest.

The installation in all of its parts has been constructed by the Western Electric Company, which was the concern which installed the old Cortlandt street board, and which as much as any other single agency has contributed to the forward condition which the art of telephony has attained not only in this country but abroad.

Nearly all branches of electrical engineering have been drawn upon in making this telephone installation, and to deal exhaustively with even one of the important details of the work would take up the entire time of the meeting.

ALTERNATING CURRENT MACHINERY FOR HIGH AND LOW FREQUENCIES—II.

BY B. A. BEHREND.

(Concluded.)

If a higher speed can be obtained for driving the alternators, the difficulties attendant upon the construction of sixty-cycle, slow-speed generators disappear. Generators for sixty cycles and 1,000 or 2,000 kilowatts running at about 180 revolutions per minute make very fine designs. A moderate number of poles combined with a high peripheral speed furnishes a construction which is at once compact and advantageous in regard to the electrical design. A 1,000-kilowatt generator for 2,200 volts and sixty cycles, running at 180 revolutions per minute and having, therefore, forty poles, is illustrated in Fig. 3. The normal surface speed of this machine at 180 revolutions per minute is 6,700 feet per minute, but, as it was to be direct-connected to a water-wheel, it was deemed advisable to test it at 315 revolutions per minute, a twelve-foot wheel revolving at this speed being quite an impressive sight, especially to a man standing close to it and taking the speed.

The mechanical construction of the revolving fields for high peripheral speeds requires a great deal of attention. The centrifugal forces per pole amount, in some cases, to thirty and forty tons, and the pole has to be safely held on to the rim of the spider. Fig. 5 illustrates the construction of a revolving field of seventy-five inches outside diameter, having eighteen poles and revolving at 400 revolutions per minute. The normal surface speed of this field is 8,000 feet per minute. The spider is made of cast steel, completely turned, with slots milled in it to receive the poles, made of steel laminations. The field windings are, of course, made of copper strip wound on edge. Such wheels are almost indestructible. The spider illustrated in Fig. 5 belongs to a 600-kilowatt generator operating in the Denver Gas and Electric Company's station in Denver, Col. Two of these machines are represented, in Fig. 5, in the power-house.

Let us now turn our attention to alternating-current generators for a frequency of twenty-five cycles. In Fig. 6 we show an assembly of a 425-kilowatt generator having twenty-eight poles and producing three-phase currents at 400 volts. The speed of this machine is 107 revolutions per minute. The bore of the armature is one hundred inches, the length of the pole being twelve inches. The output of this generator, reduced to the same speed, is only twenty-five per cent smaller than that of the sixty-cycle generator illustrated in Fig. 1, but a glance at the dimensions of these two machines shows how materially they differ from each other. The sixty cycle, 600-kilowatt generator has a bore of the armature of 180 inches, while the bore of the armature of the twenty-five-cycle generator is 100 inches, the length of the arma-

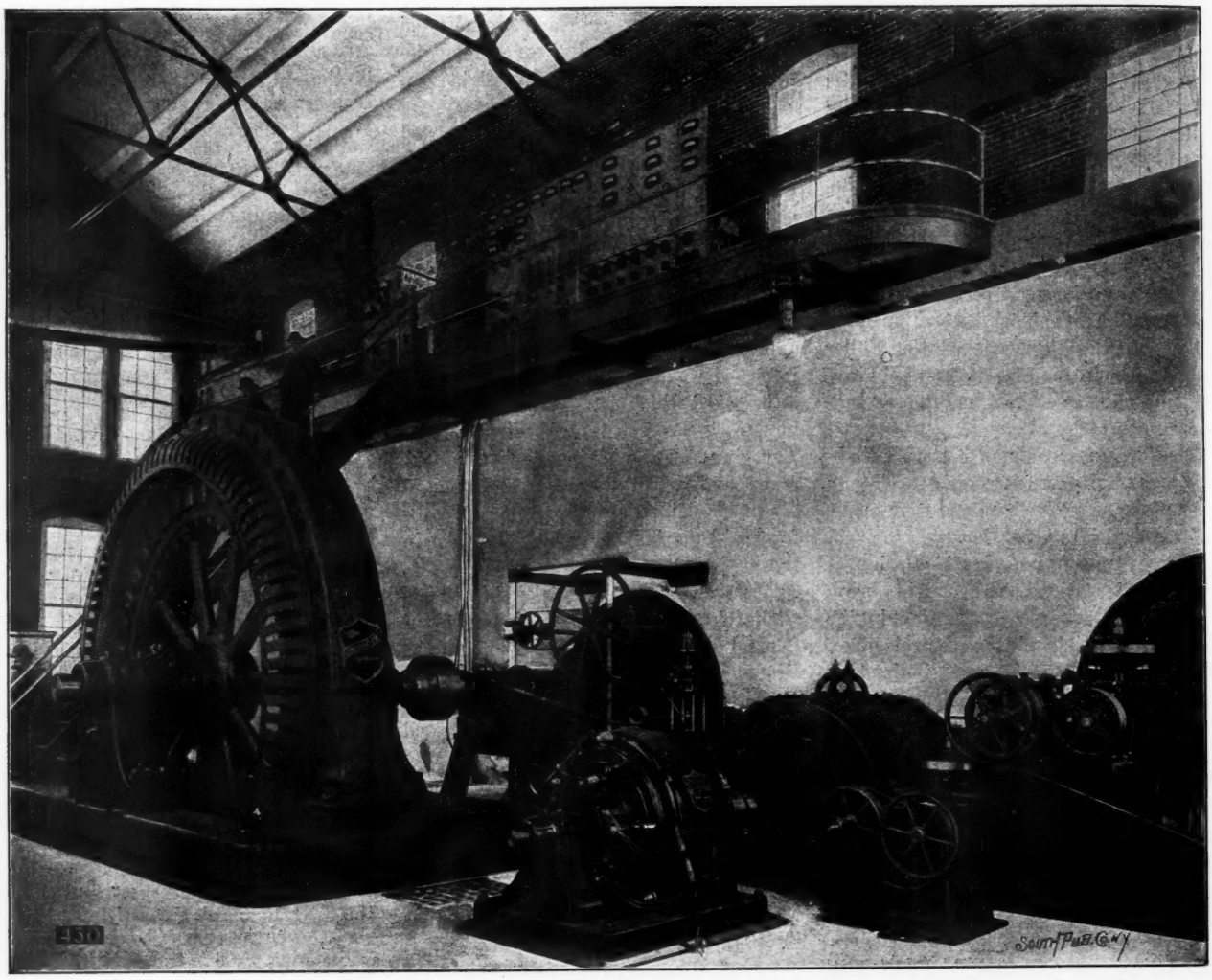


FIG. 3.—VIEW OF 1,000-KILOWATT GENERATOR.

ture of the former machine being about one-half the length of the latter. The amount of active material, such as copper for the windings and sheet steel for the armature and poles, is very nearly the same in both machines, but it needs no comment to show that the twenty-five-cycle generator is considerably less expensive to build. While the sixty-cycle generator naturally lent itself to the construction of a flywheel type, it would be absurd to make the twenty-five-cycle generator into a flywheel type. Only for very large outputs of 5,000 kilowatts and above it commends itself to make the twenty-five-cycle generator into a flywheel generator.

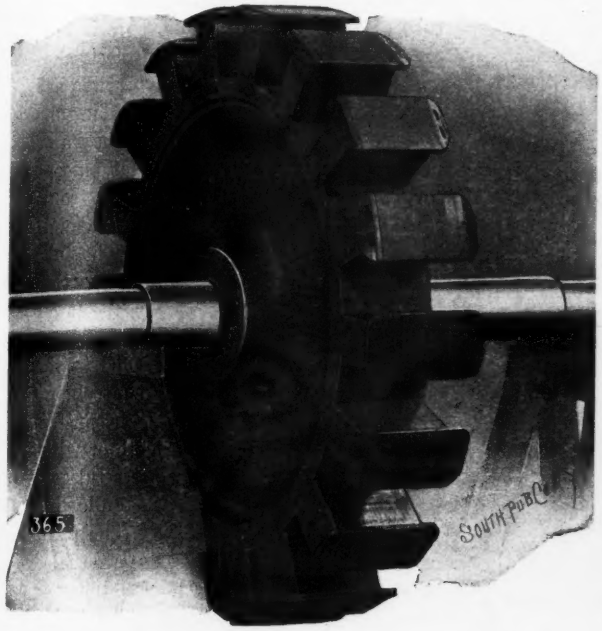


FIG. 4.—VIEW OF ROTATING ELEMENT WITHOUT COILS.

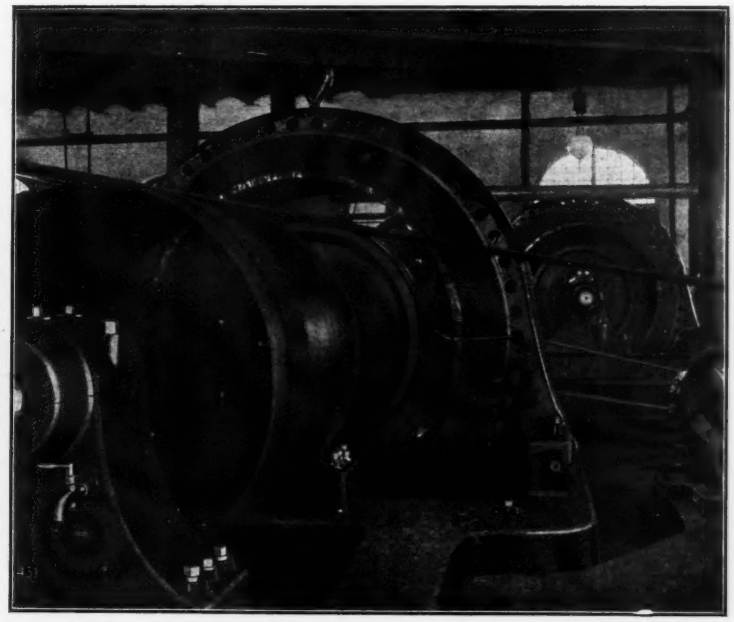


FIG. 5.—TWO 600-KILOWATT ALTERNATORS.

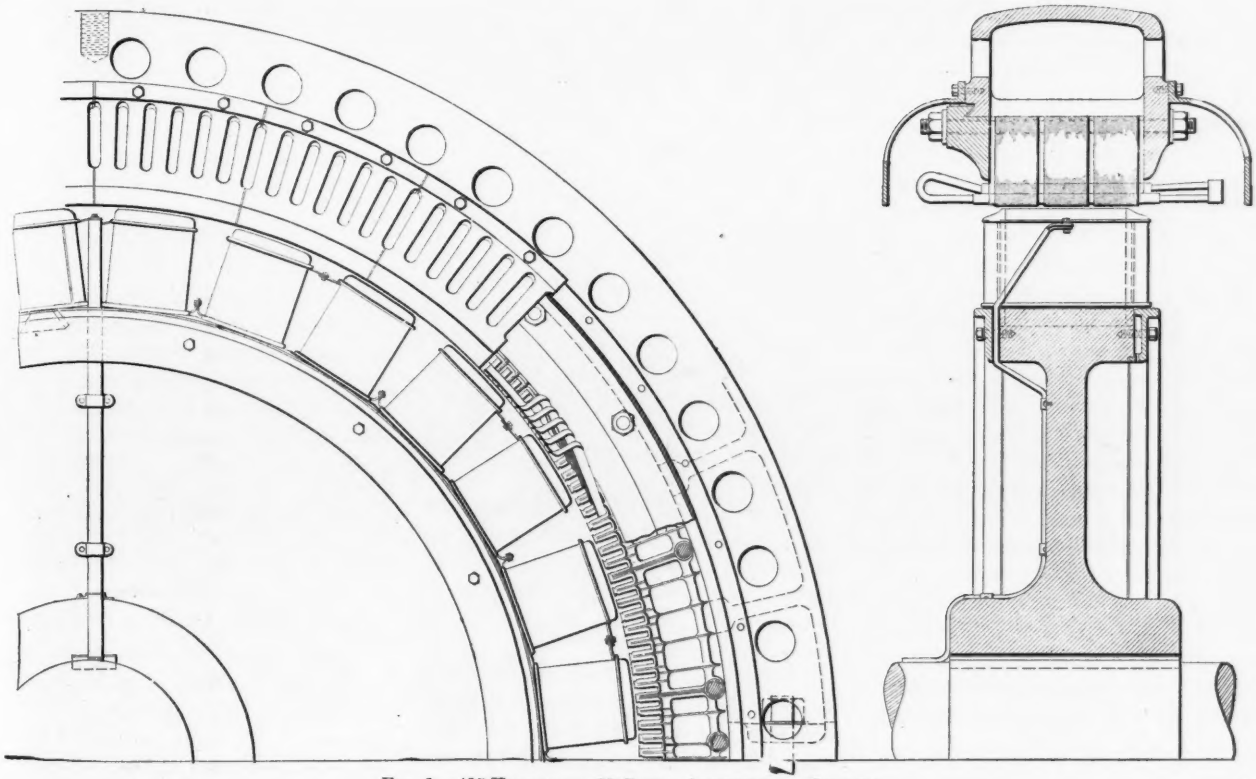


FIG. 6.—425-KILOWATT, 25-CYCLE ALTERNATOR DETAILS.

It is interesting to compare direct-current motors which operate naturally at a low frequency with high-frequency motors. And in order to make the comparison more instructive we will take two 450-horse-power motors running at 160 revolutions per minute. The direct-current motor had ten poles. Its frequency, therefore, was 13.4 cycles. The alternating-current motor had forty-four poles, its

frequency being sixty cycles. The following table shows the main dimensions, weights, temperature rises and efficiencies of both types of machines side by side:

	Direct Current Motor.	Three-Phase Induction Motor.
Number of Poles	10	44
Diameter Armature	57 in.	156 in.
Length of Pole	19¼ in.	8¼ in.
Weight of Copper, Armature	1,950 lbs.	2,060 lbs.
Weight of Copper, Field	2,250 "	1,850 "
Weight of Copper, Commutator	1,800 "	.....
Weight of Steel, Armature	10,000 "	4,200 lbs.
Weight of Sheet Steel, Stator	7,100 "	9 300 "
Weight of Rotor	17,500 "	24,900 "
Weight Total	90,000 "	85.000 "

	Direct Current Motor.	Three-Phase Induction Motor.
Temp. Rise. Armature Surface	22° C.	12° C.
Temp. Rise. Commutator	32° C.	.....
Temp. Rise. Field Coils	40° C.	8° C.
Efficiencies. 1½	93¼	92.6
Efficiencies. 1¼	93¼	93
Efficiencies. 1/1	93	92 6
Efficiencies. ¾	92.2	92
Efficiencies. ½	89.6	90
Efficiencies. ¼	82.6	83.5

From these figures in this table we see that the compact direct-current motor weighs about the same as the disc-like induction motor. The cost of material in both machines is approximately the same, but the total cost of the induction motor is higher, owing to the greater expense of machining, winding and handling the larger parts.

In regard to parallel operation, both twenty-five and sixty-cycle generators can be run successfully in multiple, but the sixty-cycle generators require, of course, a higher degree of uniformity of angular velocity of the prime movers. As in most modern plants careful attention has been given to the engine and its governor, difficulties are now rarely incurred on this score.

In summing up the distinctive characteristics of alternating-current machinery for the two standard frequencies of twenty-five and sixty, particular emphasis should be laid on the properties of rotary converters and motor-generator sets. It is perfectly possible to build rotary converters for sixty cycles but, in the great majority of cases, the station engineer will prefer the motor generator on account of the smaller number of brush-studs with their brush-holders. Surely it is extremely unpleasant to have to attend to twenty-eight brush-holder sets in a 1,000-kilowatt rotary if you can get along with twelve sets in a motor-generator set.

In order to get a basis of comparison, let us consider, on the one hand, rotary converters for twenty-five cycles for 250 kilowatts and 900 kilowatts respectively, and motor-generator sets for either the same frequency or for sixty cycles. The results of the comparison are put together in the following table:

	K. W.	R. P. M.	Efficiency. 1/1	¾	½	¼	Price.
Rotary Converter	250	500	89.8	89	86.2	77.5	$4,000 00
Motor Generator	250	500	86.8	83.2	78.5	66.5	5,200 00
Rotary Converter	900	250	92.8	91.8	88.5	82.5	11,400 00
Motor Generator	900	250	91	89	84	75	16,200 00

The efficiencies given are the combined efficiencies, including the transformers for the rotary converters, but not including these for the motor-generator sets, which are supposed to be wound for 6,600 volts. The motors driving the direct-current generators are supposed to be synchronous motors, but the figures given would change only immaterially for induction motors. The price is the approximate selling price for the complete outfit.

A study of this table shows clearly that in regard to efficiency and cost, the rotary converter is superior to the motor-generator, and if it were not for the complication arising from the great number of poles, rotary converters would be exclusively used. On account of this complication, the motor-generator set is preferable for fifty and sixty cycles in spite of its greater cost and somewhat lower efficiency.

To condense the facts of this article, we may say that the twenty-five-cycle system has a powerful ally in the rotary converter. The power plant and the whole electrical equipment, excepting the transformers, are more economical from an engineering and from a commercial point of view. The twenty-five cycle plant is thus extremely well adapted to the distribution of power and of light wherever three-wire direct-current systems may advantageously be installed. Series arc lighting has to be done by arc light dynamos driven by synchronous or induction motors for twenty-five cycles, or by frequency changers.

The development of the series alternating-current arc systems is, at present, the mainstay of the sixty-cycle systems, although incandescent lighting is not at all a negligible factor in determining the choice of the frequency.

The improvements which are constantly being made in this direction justify the prophecy that there will finally be a complete differentiation of the central stations for the distribution of power, and of such for the distribution of light. The frequency of twenty or twenty-five cycles will be used for the power systems, while the central stations for the distribution of electricity for lighting purposes will be operated at sixty cycles.

A Voltameter for Small Currents.

A mercury voltameter of remarkably simple construction is described by R. A. Lehfeldt in the *Philosophical Magazine* and abstracted in the *Electrician*. A glass tube of from 0.5 to 1.5 mm. bore is provided with a pair of platinum electrodes, sealed in near the ends, and the ends are drawn out to a small diameter. The tube so prepared is filled, by means of the water pump, with mercury throughout, except for one drop of mercurous-nitrate solution in the middle of its length. The ends of the tube are then sealed off. The tube is placed vertically, and the upper portion of the mercury made the anode, the lower the cathode. The drop of solution creeps up the tube at a rate proportional to the current flowing, the movement being measured by any convenient scale, preferably one etched in the glass, with or without a micrometer. For the successful construction of the apparatus the following points should be attended to. The parts of the tube where the electrodes are sealed in should not be widened, else difficulty in filling is likely to ensue. The filling can be done by placing the tube aslant with one point dipping under mercury in a dish. The mercury is covered by solution. When enough has been drawn in by the pump to form one electrode the point is lifted momentarily so as to allow solution to flow instead, then depressed, when more mercury enters, to form the other electrode. The filling is regulated most conveniently by a tap sealed on to the upper end of the tube, which is subsequently detached. The solution is made by weighing out 26.3 milligrammes of mercurous nitrate per cubic centimetre of water (decinormal), and adding enough nitric acid to dissolve the basic salt that forms. The current density may be anything up to ten or fifteen milliamperes per square centimetre; more than that causes polarization. Hence a tube of two square mm. cross-section (ordinary Sprengel-pump tubing) will take 0.3 milliampere. The difference between the calculated and observed motions of the drop is less than 0.6 per cent.

New Electric Railway in Mexico.

Consul-General Hanna, of Monterey, says it is understood that an American company has obtained a concession to build and operate an electric street-car line on several of the streets of that city, with extensions to Topo Chico, to the new steel plant, and to the smelters. It is also understood, the consul-general adds, that Mackin & Dillon of Monterey, are the principal promotors, and that the greater part of the equipment will probably be purchased in the United States.

Electrical Patents

A locking socket for incandescent lamps has been invented by Charles R. Barrett and Elwood C. Phillips, Chicago, Ill. The object of the present improvement is to provide a simple and efficient construction of parts in which the locking of the lamp within the socket is securely effected without interfering with the proper screwing of the lamp into place to bring its filament into circuit. Referring to the drawings, 1 represents the usual incandescent lamp having an exteriorly screw-threaded foot 2, by which attachment is had with the similarly formed orifice in the socket 3, as usual in the present type of lamps and sockets; 4 is a closed chamber located laterally at one side of the lamp socket 3 and opening into the interior of such socket, as shown. The casing forming said chamber 4 is provided with a keyhole 5 for the insertion of the key by which the lock mechanism is operated; 6 is a locking detent pivoted upon a stationary pivot pin 7 in the chamber 4, and 8 is a spring of any usual construction arranged within said chamber and adapted to force the locking detent 6 to its engagement with the lamp-foot 2. The locking detent 6 has a tangential arrangement with relation to the circular inner wall of the lamp socket, as well as the circular wall of the lamp-foot, and is provided with a pointed free end 9, which is adapted to engage in a recess or depression 10, formed in one of the spiral grooves in said lamp-foot, as shown, the arrangement being such that the lamp-foot is free to screw into the lamp socket to effect an operative connection of the lamp, the tangentially arranged locking detent 6 in such case riding in the spiral groove of the lamp-foot. Upon the unscrewing of the lamp to effect a disengagement, and as the recess or depression 10 is brought around into line with the point 9 of the locking detent 6, the said point will spring into such recess to prevent a further unscrewing of the lamp. With the present construction it will be observed that the lamp-foot can be unscrewed or turned into place to establish the electric circuit through its filament and in so doing may carry the locking recess 10 past the locking detent 6 any required distance to establish the circuit without affecting the tendency of the parts to effect a lock before the lamp can be unscrewed to a point of detachment. With such construction great nicety of adjustment of the parts is not required, and in consequence the cost of manufacture can be correspondingly reduced. Another advantage of the present improved arrangement of parts is that the locking detents 6 can be duplicated to any required extent and arranged side by side, as illustrated in Fig. 1, in the nature of lock-tumblers, so as to require a particular formation of the wards in the bit of the key 11 to effect an opening of the lock, and thus afford greater security against an authorized attempt to pick the lock. In the particular construction shown the locking detents 6 are formed of a non-conducting substance in order to prevent a short-circuit when in engagement. They may, however, be formed of metal, if so desired, in which case they will have an insulated connection with their pivot-pin 7 and spring 8.

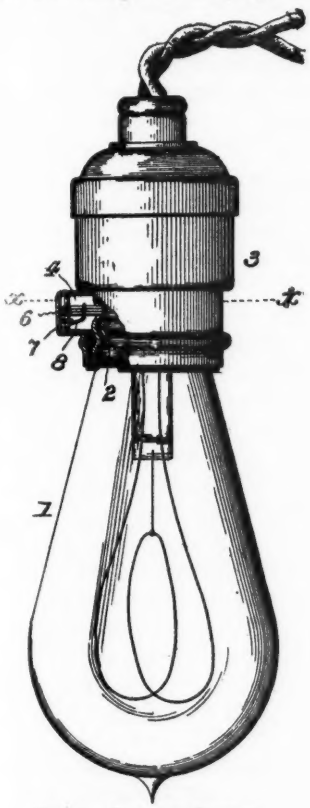
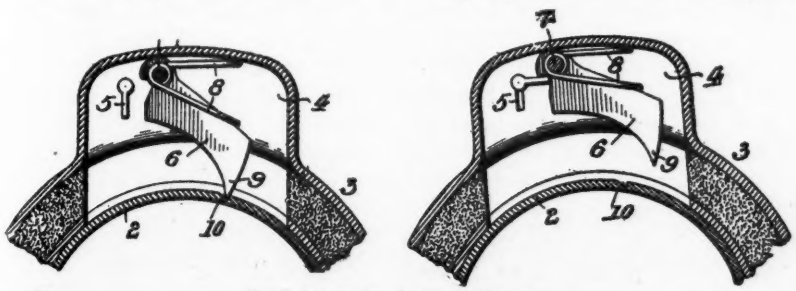


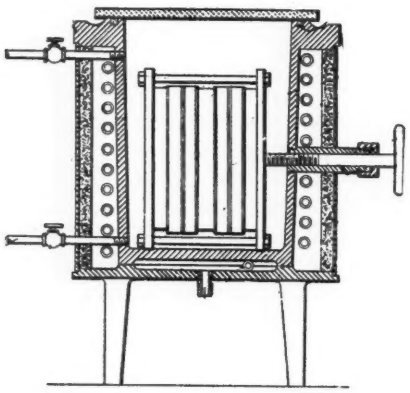
FIG. 1.—LOCKING SOCKET.



FIGS. 2 AND 3.—LOCKING SOCKET.

The General Electric Company has just obtained control of a patent recently granted to Mr. Jesse Coates, of Lynn, Mass., on a new method of manufacturing electric condensers. The various details of the invention are directed more especially toward the prevention of cracks, fissures and similar openings which are apt to be found in the insulating material of condensers as heretofore manufactured, these defects being due to the contraction of the insulating material during cooling. One of the distinguishing features characteristic of the invention is the cooling of a mass of condenser elements from the interior of the mass instead of from the exterior as heretofore. If under these circumstances cracks or fissures tend to form, the fluid insulating material about the condenser immediately flows in and fills them up, thereby leaving the insulation of the condenser when finally cooled in a perfectly homogeneous condition, free from cracks, air-bubbles or other similar imperfections. This obviously greatly improves the static capacity of the condenser and at the same time enables it to be subjected to high potentials without disastrous results. In connection with the cooling of the condensers, as thus described, means are provided whereby the contraction of the insulating material is followed up by external pressure applied through a compression screw or other suitable means, this pressure aiding in the removal of any tendency to crack which may exist as the contraction of the insulating material takes place. A treating tank is provided which consists of a vessel open at the top, the opening, however, being closed, when desired, by means of a closely-fitting, heavy glass plate. The joint between this plate and the top of the treating tank or vessel is made air-tight by means of a rubber packing of gasket inserted in a groove in the top of the tank wall. The sides of the tank are surrounded by a coil of steam pipe to which steam may be admitted through supply pipes provided with valves in the usual manner. A non-conducting shield surrounds the steam pipes to prevent undue radiation of heat, this shield being held in place and protected by means of a metal retaining casing. The bottom of the treating mark is provided with an extended edge which

rests upon and makes a fluid-tight joint with a supporting base-plate, the upper surface of which forms, in conjunction with the hollowed-out lower portion of the treating tank, a shallow chamber to which cooling water may be admitted, when desired, the admission being effected through a downwardly extending tap. A bunch of condensers is placed within the tank for treatment, and these condensers are compressed together by means of a suitable clamping screw that passes through one wall. The process of impregnation commences with a thorough baking of the condensers in a suitably heated oven, this baking thoroughly driving out and removing any traces of moisture which may exist. The condensers are then inserted in the tank, and the cover is placed in position, after which a vacuum pump is attached and the air is exhausted from the



MANUFACTURE OF CONDENSERS.

tank. The vacuum pump is allowed to operate for a considerable period, during which time the air and vapor which may be confined in the mass of the condensers escape into the chamber from which they are drawn. The elimination of the vapor is facilitated by occasionally screwing up the compression screw and then releasing the compression. After the pumping has been continued a sufficient time, molten insulating material is admitted through a suitable pipe until it completely covers the condensers. The compound thus admitted is absorbed into the condensers, being drawn into the fibres and spaces by the action of capillary attraction. After the condensers are thoroughly saturated they are cooled, this being accomplished by admitting cold water to the shallow chamber above described. Cracking is prevented by the insulating compound surrounding the condensers which, still being in a fluid state, flows in and around the mass as the same gradually contract. The clamping screw is turned from time to time so that the sheets are held in close contact. When the material has become cold the condensers are removed, the superfluous insulating material is trimmed off, and the individual sections are separated from each other.

The Teaching of Elementary Mathematics.

At a recent meeting of the Mathematical Association, at King's College, London, Professor A. Lodge read a paper introducing for discussion the subject of improvements in the teaching of elementary mathematics, which is thus reported in the London *Mechanical Engineer*. He explained that the special object in bringing the whole question forward now was to enable the association to cooperate with the British Association Committee formed for the purpose at the Glasgow meeting last year. Many teachers had been for a long time aware that the teaching of geometry in this country was suffering from being based on a fixed ancient model which, however excellent, was not in many respects satisfactory as a text-book for beginners. The efforts hitherto made had been powerless to make any appreciable effect on the action of the great examining bodies in the country, and without their cooperation much progress was not possible. Now, however, with the powerful leverage of the British Association to assist them, the association might confidently look for real and lasting progress. The best method of teaching geometry would, no doubt, be the question which would require most attention, as that was a matter in which all, teachers and examiners, must move together if at all. Men came up to engineering colleges who were slow and inaccurate in computation, who did not know the contracted methods of multiplication and division, who were as likely as not to put the decimal point in the wrong place. They wanted boys taught to be ready and rapid computers, to be able to make rough checks on their own work so as to avoid gross errors, to cultivate common sense in connection with problems, and to be in the habit of verifying answers. It had to be remembered that the pupil's mental equipment was chiefly arithmetic and algebra, and his geometry should be built on these notions as much as possible, instead of being carefully divorced from them, as was done in so many text-books. It would be advisable at the outset to adopt some French text-book as our model. The Americans had done so already, and the chief points in their books were: (1) The more orderly arrangement of propositions; (2) the entire separation of theorems from problems of construction, hypothetical constructions being used in proving a theorem; (3) the closer association of a proposition and its converse when both were true; (4) the adoption of arithmetical notions and algebraic processes; (5) the early introduction of simple *loci;* (6) insistence on accurate figures drawn by accurate and practical processes; (7) practice in exercises from the very beginning. It has been suggested that he should add, "Attention paid to the various phases of a theorem as the figure changes, and (as the student progresses) to the easier forms of generalization." The greater part of these improvements could be adopted at once, provided that the sanction of the great examining bodies could be obtained. In conclusion, he urged on all who were convinced that reform in geometrical teaching on some such lines as he had indicated was urgent and imperative, that they should not rest content until some at least of the reforms were sanctioned by the great public examining bodies. The meeting ought not to conclude without appointing a strong committee to keep in touch with the British Association Committee.

"Ethergram," from Texas.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

Referring to your issue of February 8, and the communication therein from Charles Sidney Smith suggesting the word "Ether-o-graphy" to designate the system of wireless telegraphy, and "Ether-o-gram" to designate the message, what's the matter with leaving out the letter "o"? It seems to me about as superfluous as the letter "p" in pneumonia. Call it "Ethergraph" and "Ethergram."

FRANK B. KNIGHT.

Austin, Tex., February 15.

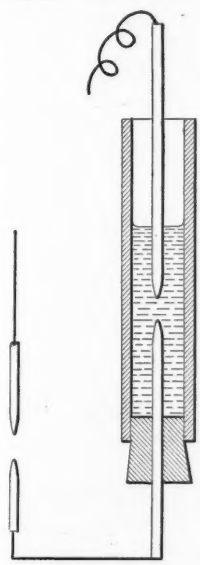
Large Electric Power Plant to be Built in Baltimore.

The United Railways and Electric Company, of Baltimore, Md., has closed a contract with the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., for four immense electric generators of 2,000 kilowatts or about 2,800 horse-power each. The United company is operating the old World's Fair Westinghouse machines, which are rated at 750 horse-power each. These machines were among the most noteworthy exhibits at the Chicago World's Fair, and at that time were the largest electric generators in the world. The new machines will generate three-phase alternating currents at 13,000 volts and 3,000 alternations per minute. This current will be transmitted through light cables to substations where, by means of transformers and rotary converters, it will be "stepped down" and converted to direct current at 550 volts for distribution through the trolley wires. The contract includes transformers, rotary converters, switchboards and all necessary auxiliary apparatus.

THE ELECTRIC SPARK IN WATER.

BY PROFESSOR JOHN TROWBRIDGE.

The study of the electric spark in water is of interest from the point of view of the modern ion theories, and also in regard to lightning discharges in regions surcharged with aqueous vapor. It is possible to produce a brilliant discharge even in carefully distilled water if a high electro-motive force is employed. I have found 500,000 volts with a large capacity suitable for the purposes of spectrum analysis. The electrodes were platinum wires inserted in long glass tubes and were placed



ARRANGEMENT OF SPARK-GAPS.

an inch apart. It is necessary to have an additional spark-gap outside the liquid. The arrangement is represented in the illustration.

The light of the spark which is produced under water is of brilliant whiteness, resembling that of an enclosed arc lamp. It gives to the eye, apparently, a perfectly continuous spectrum. When, however, this spectrum is photographed indistinct bands are noticed where the aqueous vapor spectrum bands exist in the spectrum of rarefied water vapor or in steam. I think this is an interesting fact, and it leads me to suppose that the continuous spectrum accompanying air lines, noticed in the spectrum of lightning, is due to water vapor and, further, that the faint continuous spectrum one always obtains with powerful electric sparks in air is due to water vapor, and also that the faint continuous spectrum in X-ray tubes is also due to this vapor.

One is naturally puzzled to account for the brilliant light of the spark under water. It seems almost as if it was due to the incandescence of a solid. I am inclined to attribute it, certainly in part, to the combination of oxygen and hydrogen produced by the dissociation of the water. Good authorities, however, do not believe that there is an electrolysis of distilled water by the electric spark. I am inclined to believe that a dielectric, or a poor conductor, is merely a gas, that is, in the same sense as a sugar solution is according to Van't Hoff's hypothesis, and certainly an electrolytic process takes place under the effect of high electro-motive force in a gas. The powerful discharges liberated a cloud of fine particles of air or gas. It is difficult to decide whether this cloud consists of air or oxygen and hydrogen. In certain cases strong explosions take place in the tubes containing the immersed terminals. These explosions are erratic and can be supposed to be due to the right proportions of air and hydrogen or to the mixtures of oxygen and hydrogen. The mere heating produced by the spark is not sufficient to explain the explosions.

In order to further study the phenomena I covered the surface of the water with a very thin layer of oil. I immediately obtained a very interesting case of what Quincke terms a troubled solution (*Ann. der Physik,* No. 1, 1902). The water is filled with finely subdivided particles of gas, so finely subdivided that it is of a milky hue. It seems probable that an emulsion is formed of water, air and minute quantities of oil, somewhat similar to the emulsions formed by apothecaries of oil, gum, arabic and water. This electrical emulsion lasts for hours, possibly days. The finely divided particles of gas become coated with oil, and one can conceive them existing like minute soap bubbles.

When one of the platinum terminals is merely immersed in the surface of the water the spectrum immediately changes to the so-called four-line spectrum of hydrogen, such as one sees when the electric spark is produced in a dense cloud of steam. I have always been firm in the belief that this so-called four-line spectrum of hydrogen is due to water vapor. In this case we have a powerful dissociation of the water in air by means of the spark. While the four-line spectrum of hydrogen is more evident to the eye a photograph shows also in the invisible portion of the spectrum strong oxygen lines. In the spectrum of lightning we ran through the gamut of continuous spectrum, hydrogen and oxygen lines, aqueous vapor bands and nitrogen lines. I think this variability in condition of water vapor and rarefaction explains the different spectrum of lightning obtained by various observers.

Jefferson Physical Laboratory, Cambridge.

Electrical Statistics.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In pursuit of a fad of mine for collecting data of the engine and dynamo equipment of central stations all over the world, I have followed fairly closely the American, English, German and French electrical press for the past twelve years. Until recently I have been inclined to rank the English papers as easily first, both in number of descriptions and completeness of detail, but I am glad to see that the American press is now seriously disputing this supremacy, and beg leave to congratulate the ELECTRICAL REVIEW for its very active share toward this desirable result.

GEORGE THORNTON PAGE.

Cambridge, Mass., February 5.

Proposed Electric Railroad in Sweden.

Consul Robert S. S. Bergh writes from Gothenburg, that the problem of employing electric power instead of steam for railroads receives more and more attention in Sweden. It is stated that the managers of the state railroads are making investigations in this direction, and a recent newspaper article announces that private concerns are also interested in the matter. A Gothenburg newspaper reports that the board of managers for the Falun-Vesterdalarnes Railroad Company has sent to the government a petition for the gradual adoption of electric locomotives instead of steam engines throughout the whole country, and the utilization of water power. The petition mentions that a machine firm in Switzerland has made a proposition to use the Huber system, by which an electric current can be generated when a train passes down inclines, which current can be utilized by other trains on the same road. The Swiss firm proposes to furnish the necessary rolling stock, a Swedish company will supply the electric power, and the railroad company is to furnish railroad lines for the experiment. But cash is still needed for the building of transformers, for raising the current to 16,000 volts and changing the same from three-phase current to two-phase, for electric connection of the rails, etc., all of which it is estimated will cost 100,000 kronor ($26,800). The petitioners ask the government to furnish the money needed.

Consul George W. Roosevelt writes from Brussels, Belgium, that owing to the very satisfactory results obtained from the Stone system of electric lighting, now employed in 205 cars, it has been decided to extend its use to 141 additional new cars.

Independent Telephony at Charleston, W. Va.

One of the best equipped and most modern in every way is the plant of the Kanawha Telephone Company, at Charleston, W. Va. The exchange is situated over the Kanawha National Bank, in the central part of the city. The plant is entirely new property, all material used in its construction being standard and in the latest type. It was built by the Northern Construction Company, of Bryan, Ohio. All apparatus, consisting of switchboard, telephones, arresters, protective devices, etc., was furnished by the Kellogg Switchboard and Supply Company.

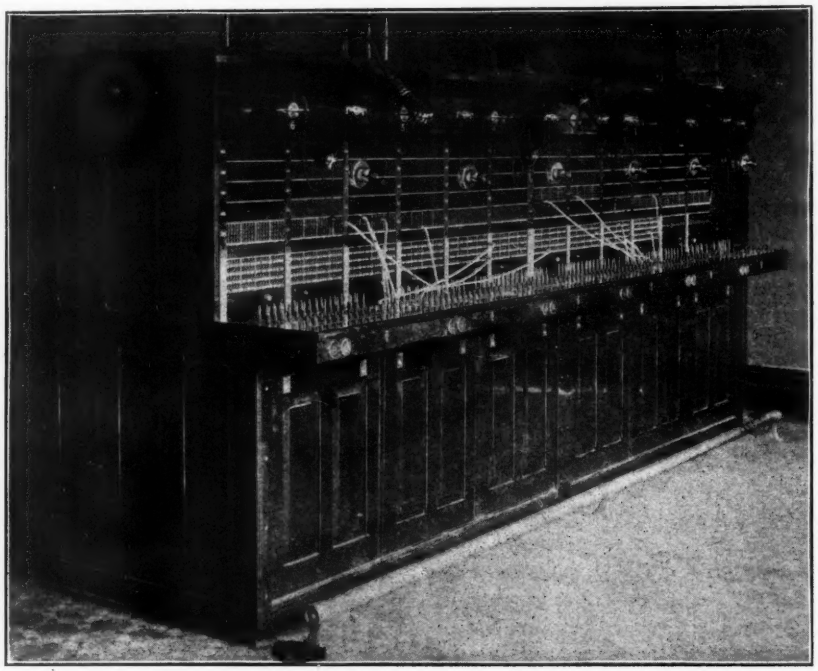


FIG. 1.—MAIN BOARD, TELEPHONE EXCHANGE, CHARLESTON, W. VA.

The ultimate capacity of the exchange is 1,400 lines. The switchboard is of the "Major" relay type, the lamp signals and central battery, all sources of current both for talking and signaling being located at the central office. The switchboard consists of two sections, each with a capacity of 1,400 multiple lines. The first end position has toll equipment and the usual multiple equipment for local lines. The second, third, fourth, fifth and sixth positions are equipped with 160 answering jacks and lamps, twenty per strip; also fifteen pairs of cords complete. The line and supervisory pilot lamps are placed at each of the second, third, fourth, fifth and sixth positions and wired in connection with the general pilot relays and a high-wound buzzer located in the box panel. The first section has a capacity of 321 to 800 multiple lines, the second position one to 320 lines.

The switchboard section is constructed of angle iron and the frame is completely enclosed with mahogany, the woodwork having a dull finish. The line lamps and answering jacks are mounted in alternate strips, as is customary in boards of this type, thus bringing the location of each jack immediately above the corresponding line lamp. The combined ringing and listening key and the two supervisory lamps which constitute part of each cord circuit are placed in the key shelf directly in front of the pair of cords to which they correspond.

The relays controlling the supervisory signals are mounted on a rack attached to the rear of the iron frame, these being shown in Fig. 2. The line and cutoff relays, however, are located in a relay rack separate from the board itself. Each relay, whether line cutoff or supervisory, is provided with an individual shell of drawn steel, screw-threaded and adapted to screw on to the mounting plate of the relay, thus completely enclosing it and rendering it dustproof. In Fig. 3 is shown the iron rack upon which is mounted sneak current and lightning-arrester equipment. A buzzer is wired in circuit with the sneak-current arresters, which sounds when any arrester is open. The former is manufactured under one of the Kellogg company's patents and differs materially from former types, in that the heating-up process is not dependent upon the resistance of a coil of wire. In the foreground of Fig. 4 is shown the intermediate distributing frame, and just behind it is situated the relay rack and in the rear the main distributing and arrester frame. At the top of this illustration is also clearly shown the method of cabling between these frames. The wiring is begun by attaching to the arrester strips, on the main distributing frame, sufficient twenty-one-pair cables to carry 800 lines, these are then carried to the line and cutoff relays on the relay rack. From the proper terminals at this point the lines are carried by means of sixty-three-wire cables to the relay side of the intermediate distributing frame, where they are jumpered to the switchboard side of this frame with jumper wire. From the switchboard side terminal lines are carried direct to the answering jacks and lamps at each operator's position in sixty-three-wire cables. Twenty-one-pair cables leading to the multiple taped into the tip and sleeve of the lines on the relay side on the intermediate frame. All multiple cabling is done with twenty-one-pair cables. The power plant consists of twenty-two cells of storage battery and duplicate charging and ringing machines. The latter may be seen on the shelf against the wall in Fig. 3, while the battery is located in a cupboard at the right of the machines.

In the rear is located the power board,

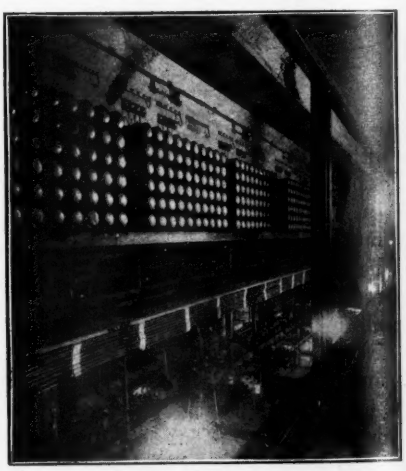


FIG. 2.—REAR OF BOARD, SHOWING CABLES AND LINE RELAYS, CHARLESTON, W. VA., TELEPHONE EXCHANGE.

which consists of Monson, Me., slate, in one piece, mounted on an iron frame; this is provided with flush pattern Weston ammeters and voltmeters, under the overload circuit-breakers, starting boxes, rheostats and the necessary switches. The design and workmanship of everything connected with this system are of the very best. This is the same type of board this company is building at Philadelphia. The circuits are such that but two contacts are required in both answering and multiple spring-jacks,

and this fact admits a reduction in size of the jack to such an extent that it is possible to build a straight multiple switchboard with 24,000 lines capacity.

During the conversation each subscriber has under his control, by means of a switch-hook of his instrument, one of the two supervisory lamps associated with the pair of cords which is being used in the connection. When the receiver is off the hook the lamp is lighted, and *vice versa*, as before connection is made his line is under control of his hook, the subscriber, under all possible line connections, is enabled to signal the central office.

It will appear from the above that when the operator has plugged into the jack of the subscriber called for and has rung him up, the lamp supervising his line lights up and remains lighted until he removes the receiver from the hook, the operator thus having a visual indication as to whether the call has been answered, and listening in to ascertain this fact is avoided. When both supervisory lamps are lighted the operator knows definitely that both subscribers have hung up and desire disconnection. If one subscriber desires another call immediately, he moves his switch-hook up and down, thus "flashing" his supervisory lamp. All these features increase the rapidity and accuracy of service to such an extent that fewer operators are required for a given number of lines.

FIG. 3.—MAIN DISTRIBUTING AND ARRESTER FRAMES AND SWITCHBOARD, CHARGING AND RINGING MACHINES, AND BATTERIES AT THE RIGHT, CHARLESTON, W. VA.

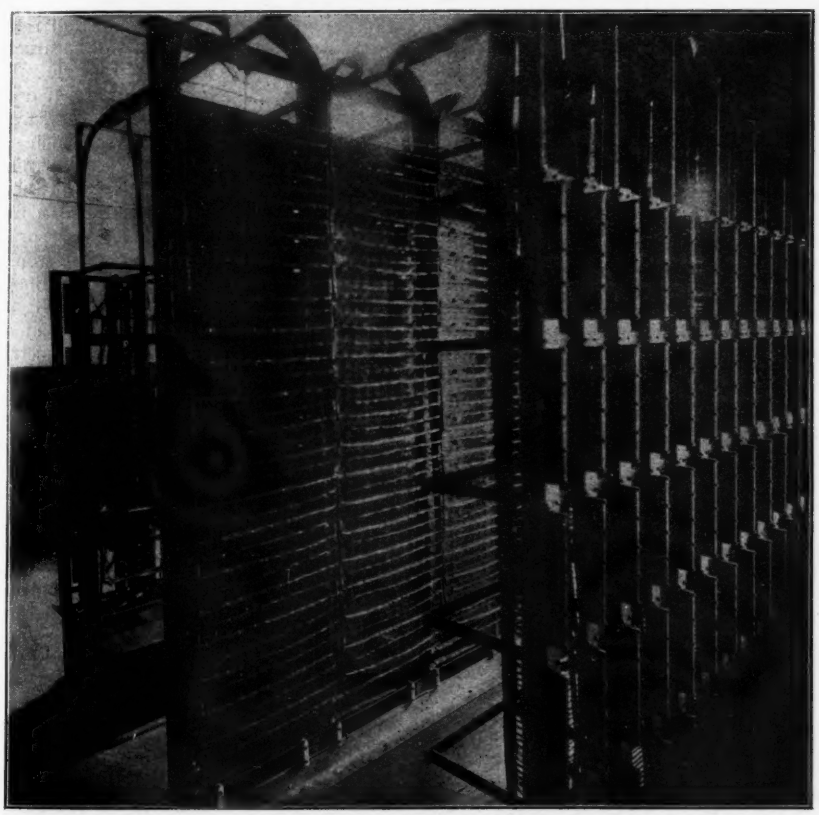


FIG. 4.—INTERMEDIATE DISTRIBUTING FRAME, RELAY RACK, MAIN DISTRIBUTING FRAME AND ARRESTERS, CHARLESTON, W. VA.

Automobile Club of America.

On Friday evening, March 7, 1902, the Automobile Club of America will hold its third annual banquet at the hotel Waldorf-Astoria. Invitations have been sent to a number of men prominent in national, state and city affairs, and it is hoped that the guests and the club will be honored by a large attendance.

Eddy Electric Manufacturing Company.

The Eddy Electric Manufacturing Company, of Windsor, Ct., has been placed in the hands of a receiver. Mr. Norman McD. Crawford, a director of the company, has been appointed receiver and will direct the affairs of the company. It is presumed the company will continue in business as it is one of the oldest manufacturers of electrical machinery and has had a very excellent career. Mr. Arthur D. Newton, general manager of the company, is quite well known in the electrical field, and his many friends trust he will soon be able to overcome the present embarrassment of his interests.

The Interference of Sound.

On January 17 Lord Rayleigh opened this season's Friday evening meetings at the Royal Institution, London, England, with a discourse on the interference of sound. In the course of his remarks he described some of his recent experiments with fog-horns made for Trinity House. Fog-horns with elliptic cones instead of circular ones were tried, the major axis being about four times longer than the minor one. The experiments showed that the sound was best spread in a horizontal direction when the long axis was exactly vertical. It appears to be doubtful whether the phenomenon of the silent area is really due to interference between waves of sound reaching the spot direct and those reflected from the sea. If the effect were merely due to interference in this way it ought to be possible to recover the sound by the listener changing his altitude above the sea surface, but Lord Rayleigh has on several occasions tried this on board the Irene and has not recovered the sound.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XXVII.

BY A. E. DOBBS.

TRANSMITTERS.

It is a rather difficult matter to write transmitter specifications, as manufacturers and engineers realize that the granular carbon transmitter is not a perfect one. But it is the best for all-round work yet discovered, and until a perfect one is found, there is a constant effort to improve the one we have, which results in a change in its shape, form and size about every two years.

The transmitter, being the very heart of the telephone system and the part most liable to get out of order, there is a keen desire among manufacturers to produce one that will not pack (packing is caused by granules being wedged together, thus preventing free movement of the diaphragm), which is the first consideration and the greatest fault with all granular carbon types; for, if the liability to packing can be overcome, there is nothing else to make trouble except a liability to dampness which can easily be excluded —and a transmitter will, therefore, need no attention from one year to another. About once every six months some manufacturer thinks he has solved the problem and announces a "non-packing" transmitter, blows his horn with the power of a compressed-air megaphone for six months, subsiding as the reports from his customers come in, contents himself with the more modest announcement that his transmitter is "as good as the best on the market," which latter statement is probably true. Even the Bell company has lately brought out a new transmitter to supersede the famous White form to which they clung for so many years as the capstone of all granular transmitters.

The tendency among manufacturers, however, is to confine the carbon in a small button near the centre of the diaphragm which, to a certain extent, follows the old Blake idea which seems theoretically correct and practically has given so far the best results. The chamber in which the granular carbon rests should be excluded from the outside air in order to prevent the absorption of moisture, as damp carbon becomes worthless in a short time.

The resistance of the average local battery transmitter varies over quite a large range, but the tendency among manufacturers is to increase the resistance and thus we have transmitters with an average resistance of from sixty to even one hundred ohms. A transmitter with a high resistance saves battery and does well enough for local service, but for long-distance work transmitters of thirty-five ohms or even less will give better results as a rule. On account of the higher voltage used central battery transmitters run considerably higher than those intended for local battery work. The only real test of a transmitter, however, is to put it on a line or several lines and try it a few months.

The case in which the transmitter is mounted should be solid enough to prevent any movement of the adjustment or parts should it be jarred by the hand or pulled up and down. If mounted on a cast-iron arm, in the usual way, the battery connection to the head should be made by means of two conductors passed through the centre of the arm. No conducting cord to the transmitter head should be carried outside the arm, nor should the hinge in the arm ever be used as a part of the battery circuit.

INDUCTION COIL.

The induction coil should be from four to five inches in length, and for ordinary exchange work have a secondary winding of about 225 ohms, although consideration should be had to the resistance of the transmitter and the probable amount of battery used.

GENERAL.

All parts of the instrument woodwork should preferably have a well-rubbed oil finish, but perhaps this is too much to expect at present. The wood should be thoroughly seasoned, and filled with oil, inside as well as out, to prevent absorption of moisture and consequent swelling. Parts of the box should not only be dovetailed and fitted together with glue, but should also be further secured in place by means of screws or wire nails.

Specifications covering bridging telephones are much the same, except that the generator should be heavier, should ring at least twenty 1,000-ohm bells in multiple, or more, if required; have sensitive and low-resistance transmitters, and, unless intended for party lines or lines of high resistance, have a low-wound induction coil, but having high inductance.

There are manufacturers who can supply instruments just described, if asked to do so, though they will probably charge a little more than $9.50 for them, but they will be worth more than the kind generally sold.

New York Section of the Society of Chemical Industry.

A meeting of the New York section of the Society of Chemical Industry was held at the Chemists Club, New York city, Friday evening, February 21. Numerous papers were read and much interest found in the meeting. A large number of members attended.

Electrical Progress in Japan.

The London *Electrical Engineer* makes the following interesting statements: The Tokyo Electric Railway Company is paying a dividend of twenty-six per cent per annum, which indicates a success not often attained in this country. In Tokyo at the present time there is no other means of street communication, if we except a small line of horse cars, and it would be a matter for great surprise if the electric cars did not pay handsomely. The field in Japan for electric traction is certainly a large one. There is water power at various places, plenty of coal, and labor is cheap. In electric lighting the country is just in the same primitive position as it is in regard to electric trams, but what electric lighting undertakings there are are proving most successful. To quote the case of Tokyo again, the company which is conducting the electric lighting business in that place paid a dividend at the rate of ten per cent per annum for the last half year, the net profit being £13,700. Some progress in electric traction in other parts of Japan is shown by the announcement of the Yokohama Electric Tramway Company to commence work in the construction of an electric system in that city, but enterprise in this direction is at present very slow. There also appears to be a great want in Japan of electric railways. From the reports before us it does not seem that the country is very well served by the steam railways, which in some cases are barely able to give accommodation to passengers and carry on their goods traffic at the same time. We are sure that the presence of a few enterprising electrical engineers in Japan would do much to remedy the present inanimate state of affairs in regard to electric lighting and traction. An amusing incident is recorded in connection with the electric tramways running between Kozu and Yumoto, which shows the spirit in which the peasantry regard the electric cars. It seems that a man living in a village through which the line passed was unfortunate enough to have his legs crushed under the wheels of an electric car. Immediately his fellow-villagers assembled around the tramcar, and were wreaking their vengeance on the vehicle, which had apparently brought similar mishaps before, when the police put in an appearance and succeeded in suppressing the disturbance.

Executive Committee of the International Association of Municipal Electricians.

The executive committee of the International Association of Municipal Electricians will meet to-day, February 22, at Corning, N. Y., at the home of Secretary Foster. All indications point to a full attendance, as matters of interest and importance will be discussed.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

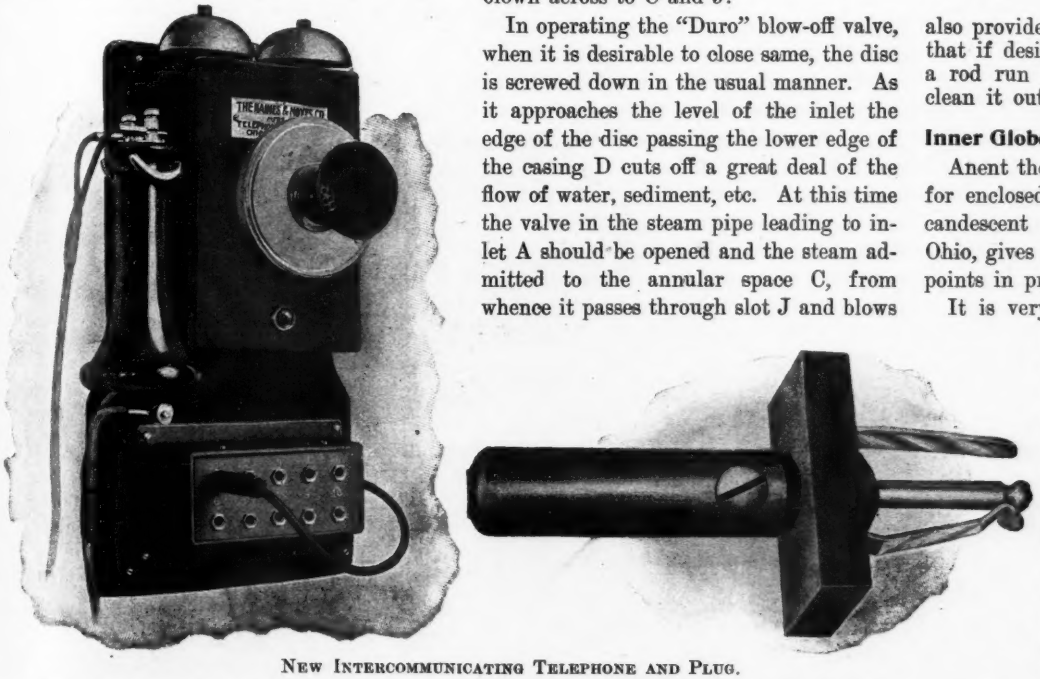
Intercommunicating Telephones.

Telephone manufacturers are spending every effort of time and expense in order to make their instruments more useful and available to their patrons.

This is especially so with the makers of intercommunicating systems. Hotels, hospitals, large business enterprises and possibly transoceanic liners are finding new value in telephony due to the perfecting of intercommunicating systems.

The Haines & Noyes Company, Chicago, Ill., is placing large contracts all over the country. The company has recently placed on the market an improved type of central energy, intercommunicating telephone, with non-packing transmitters of heavy cast brass, bipolar, pony bell-type receivers, with water-shrunk, hard rubber shell. The illustrations show the new telephone instrument, and plug and switch.

For the purpose of introducing its hand microphone to the trade, the company is making a special offer to sell two or more of these at low nominal cost, sent



NEW INTERCOMMUNICATING TELEPHONE AND PLUG.

C. O. D. This hand microphone has a hard rubber grip. The contacts are in the handle, while the metal parts are heavily nickel-plated. It contains the well-known Haines & Noyes non-packing transmitter and bipolar pony watch receiver of permanent adjustment with water-shrunk, hard rubber shell. It is also furnished with an extra long cord. The special offer holds good until April 1, 1902.

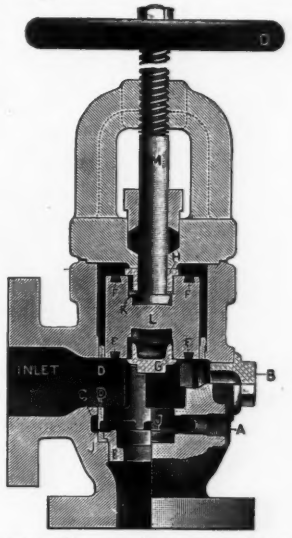
An Improved Blow-Off Valve.

Blow-off valves have probably given as much trouble as any of the other fittings which are part of the boiler equipment. Many kinds have been placed upon the market claiming to possess the chief requisites for perfection and have been more or less successful. The Lunkenheimer Company, Cincinnati, Ohio, manufactures the "Duro" blow-off valve. This valve is the result of a long series of trials with different varieties and embodies some apparently individual features.

The accumulation of sediment and dirt in valves has, after a time, caused the parts to become worn and leaky, due to cutting as the disc approached the valve seat. In the "Duro" valve the plug fits snugly in a separate and easily removable bronze casing, which can be readily replaced when worn. Any accumulation of scale on the seat is prevented by a jet of steam blowing over it which is introduced as shown in the illustration at A, and blown across to C and J.

In operating the "Duro" blow-off valve, when it is desirable to close same, the disc is screwed down in the usual manner. As it approaches the level of the inlet the edge of the disc passing the lower edge of the casing D cuts off a great deal of the flow of water, sediment, etc. At this time the valve in the steam pipe leading to inlet A should be opened and the steam admitted to the annular space C, from whence it passes through slot J and blows off the entire surface of the seat E. In the meantime the disc is being screwed home to the seat, which also cuts off the flow of steam from inlet A as well as the blow-off from the boiler. The valve in the piping leading to inlet A can be left open at all times, as the disc of the blow-off valve would keep this outlet closed.

All parts about the valve are very heavily and substantially constructed. The seat ring and casing are removable, and as these are interchangeable new ones can be supplied at small cost. There is



SECTIONAL VIEW OF IMPROVED BLOW-OFF VALVE.

also provided a plug opposite the inlet so that if desired this can be taken off and a rod run through the blow-off pipe to clean it out.

Inner Globes for Enclosed Arc Lamps.

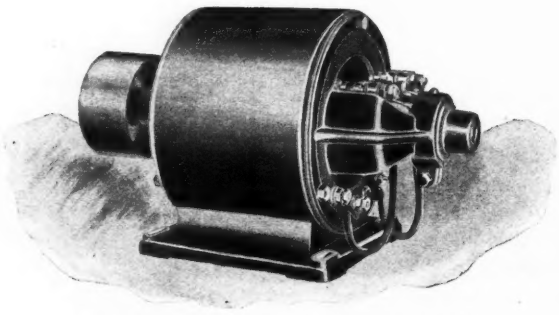
Anent the manufacture of inner globes for enclosed arc lamps, the Fostoria Incandescent Lamp Company, Fostoria, Ohio, gives particular attention to several points in producing good results.

It is very essential to have the inner globes fit exactly to the lamps so as to prevent the air from entering the inside of the globe, as a perfect fit of the inner globe will assure a longer life and less carbon deposit. It is also very important that the glass used for the purpose of inner globes should be of the highest quality to stand the high temperature of the arc and also not to break with the change of temperature which causes expansion and contraction of the bulbs.

Improved machinery for grinding and blowing has been introduced, which enables the manufacturers to give better prices. The Fostoria company in particular has experienced the same within the last year, and has been awarded a considerable percentage of the domestic and foreign business.

Shielded Type Direct-Current Motors.

The accompanying illustrations represent two views of a new type of direct-current motors lately produced by the Sterling Electric Motor Company, of Dayton, Ohio. The machines are built for small sizes only, ranging from one-eighth to one-half horse-power. All of the parts of the machine are built to gauge and standard, and are consequently interchangeable. The machines are so constructed that they may be fastened to a side wall or suspend-



SHIELDED TYPE MOTOR, COMMUTATOR END.

ed from a ceiling, the only adjustment required being the turning of the journals in their seats.

The armature is of the slotted type, bamboo strips holding the wires in place in the slots. Hard drawn copper bars and mica insulation are used in the constructions of the commutator, while the bearings are built of babbitt metal or phosphor-bronze, as desired. The brush-holders are arranged with a universal adjustment, making any position easily attained. The magnetic frame of the machine is constructed of a special composition of cast iron, which is stated to be very dense and even and of high magnetic permeability.

The illustrations show, respectively, the pulley and commutator ends of the machine. The motors are wound for 110, 220 or 500 volts and are arranged for three speeds.

Explosive Mixtures

Coal gas is explosive when mixed with air in the proportion of one volume of gas to sixteen of air, this being the inferior limit at which combustion will take place when the gases are fired at atmospheric pressure. Any proportion between this and one volume of gas to four of air may be ignited at atmospheric pressure. The best mixture to use in an engine is about ten to one of gas, though this is necessarily subject to variation on account of the different qualities of gas produced from coals of different grades.

The Business of an Interurban Electric Road.

Recently Mr. J. D. Hawkes, president of the Detroit (Mich.), Ypsilanti, Ann Arbor & Jackson Railway, wrote a letter to a friend, Mr. C. J. Kintner, in New York, containing some exceedingly interesting statements about the business of that line. It is operated in competition with a steam railroad. The subjoined extracts from Mr. Hawkes's letter are here given by permission of Mr. Kintner:

"The Michigan Central, before our electric line was built, carried 200 people a day between Ann Arbor, Ypsilanti, Wayne, Dearborn and Detroit and locally between the above named points.

"The first year the Ypsilanti electric road ran it averaged over 4,000 people a day. We never have seen a month that we did not carry more people than during the same month the previous year, and the average per day for 1901 will be nearly 5,000. Of course, you understand that we get a large patronage from Ann Arbor, where there are over 4,000 students, and from Ypsilanti, where there is a state normal school with some 1,500 students. These students are all travelers, and are with us from the middle of September until the middle of June, thus serving to steady the business during the year.

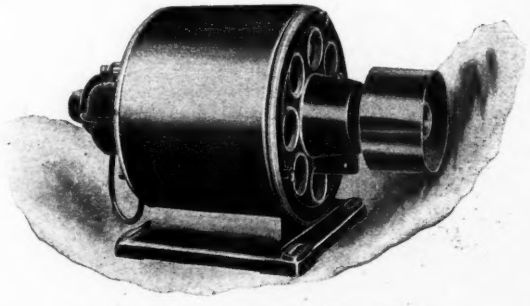
"We open our road from Ann Arbor to Jackson to-morrow (January 18) and will soon be in shape to give figures as to the increase of business handled by that extension of thirty-six miles. Data as to the freight and express matter are very imperfect. There has been a number of interruptions and the business has never acquired its proper proportions, owing to the lack of facilities for handling freight and express matter in Detroit.

"With the completion of the outbound house in Detroit the present room will be doubled and the chances for handling this business with regularity and despatch very much improved.

"We have, however, gone deep enough into the matter to know that it is going to be just as easy to get the package, freight and express business as it was the passenger trade."

Batteries Under Water.

A remarkable instance of a battery of accumulators working under water was recently given at the municipal electric plant in Munich. The station is situated on an island in the Isar, and during the flood the water covered the batteries. According to the *Scientific American*, one of the batteries which ran the car lines was completely cut out, and it was thought that the other, which furnished light, would have to be treated in the same way. The flywheels of the engines were half in the water. Nevertheless, as it was almost indispensable to light at least the principal streets of the city, it was decided to try to operate the submerged battery. The attempt was successful, and the battery, which had been constructed to give 6,000 ampere-hours with a 600 ampere discharge, was able to furnish 4,000 ampere-hours during the night. The remainder was lost in discharges in the water.



PULLEY END, SHIELDED TYPE MOTORS.

Mr. Leon Guillet, working in France, has prepared various copper-aluminum alloys by heating pure cupric oxide with granular aluminum in proportions varying from those which should yield pure copper to those which should yield the alloy $CuAl_4$. By treating the products with acids, he has isolated three distinctly crystalline definite alloys—Cu_3Al, $CuAl_2$, and CuAl, the last being mixed with a small quantity of copper-aluminum silicide.

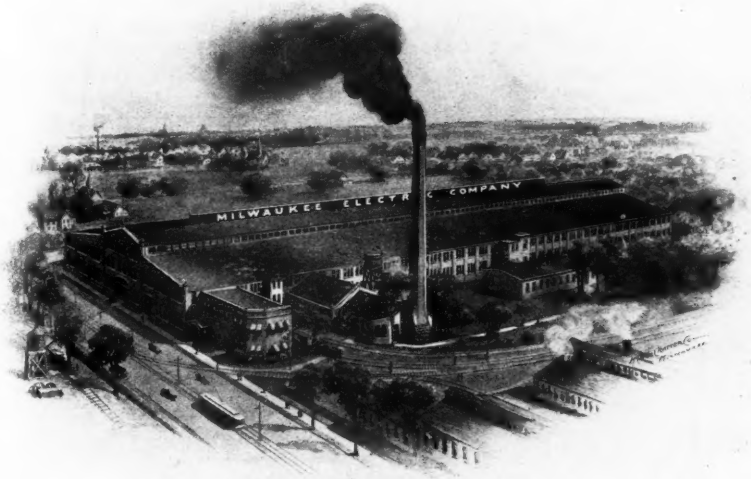
The Milwaukee Electric Company.

The Milwaukee Electric Company, Milwaukee, Wis., manufacturer of electrical machinery for power and lighting, exemplifies in every characteristic the growth and importance of this line of apparatus and the large demand which has been evidenced for it within very recent years.

This company was organized scarcely three years ago, not making a single shipment until June, 1900, and occupying about one-third the ground space now covered by the company's plant. The year just past has been a very successful one, the total from contracts aggregating some $400,000.

The present works are located at West Allis, Milwaukee, Wis., directly opposite the immense plant which the Allis-Chalmers Company is erecting. The main factory, which is shown in the accompanying illustration, is a splendid steel and brick structure 300 feet long by 120 feet wide. Thirty-foot galleries run along either side, and for facilitating the handling of heavy parts, two cranes, one of fifteen tons, manufactured by the Northern Engineering Company, of Detroit, Mich., and a smaller one of five tons, manufactured by the Case Manufacturing Company, of Columbus, Ohio, are installed.

The plant has been constructed with a view to making extensions aggregating some 800 feet in a short time. Employment may be given to from 300 to 400 men, and during this year it is expected that the factory output will be tripled.



MILWAUKEE ELECTRIC COMPANY'S WORKS, MILWAUKEE, WIS.

This company is the manufacturer of the well-known Milwaukee type (the Browning company manufacturing for the Milwaukee Electric Company in sizes from one-twentieth to ten horse-power) of electric machines. It has been building machines from one and one-half to five hundred horse-power, and from one kilowatt to five hundred kilowatts at Corliss engine speeds. It is the intention of the company to increase the size of its types up to 1,000 kilowatts.

The officers of the company are: John A. Whaling, president and treasurer; Walter Cary, vice-president; Thomas G. Whaling, secretary. The Chicago office is in charge of Mr. F. W. Kohler, western sales agent, and Mr. M. E. Baird is the eastern manager, at 39 Cortlandt street, New York city.

AVERILL MULTIPLE DUCT CONDUIT, SHOWING DOWELS AND FLANGES.

Conduit Systems.

In the present-day extensive, not to say almost exclusive, use of underground systems for the conveying of large cables carrying heavy currents from point to point, much attention is being directed along the line of improving conduit systems to the filling of the by no means meagre requirements of this class of work. While great care must be taken to attain a perfect maintenance of insulating protection, simplicity and economy of handling and construction are essential features of an available system.

In the accompanying illustrations are shown an interesting design of conduit made by the George F. Averill Company, Brooklyn, N. Y. These are vitrified multiple duct, and are claimed to give protection against all outside influences, at the same time giving complete retention of current within. These conduits are expected to greatly facilitate the work of construction; a dowel-pin and socket provide an easy method of aligning, and the deep flange makes a tight joint easy of accomplishment. The ends being well seamed and beveled on the inside of the ducts cables may be drawn through with little danger of injury to the outer coverings.

MASSACHUSETTS FAN COMPANY'S VENTILATING FAN.

Electric Ventilating Fan.

The electric fans made by the Massachusetts Fan Company, of Boston, are of the type known as the Davidson propeller, and one of them is shown in the illustration direct coupled with a General Electric enclosed type motor. The fan is constructed with a long central hub to which the blades are attached at two points. They are also connected at the outer edge to a heavy wrought iron running ring which itself is connected to the hub by five radial braces. With this construction it is almost impossible for the fan to be wrecked by any speed of revolution to which it may be subjected. The motor is held by a tripod of cast iron to the ring of the fan. The peculiar curve of the blades of the fan is claimed by the manufacturers to result in very high efficiency.

Magnetic Release Starters for Direct-Current Motors.

To the Editor of the Electrical Review:

The writer's attention has been called to an article in your January 4 issue by Mr. H. C. Heidrich, entitled "A Device for the Prompt Release of Starting Resistances."

The method advocated in this article is not only open to objections, but is contrary to standard practice and, still further, appears to the writer to be a roundabout method of accomplishing the result which Mr. Heidrich appears to desire. In the first place, it has always been considered by users and manufacturers of motors that it is neither necessary nor advisable to open the motor circuit on the instant that the supply of current may be interrupted. It is certainly an advantage to be able to throw the power circuit from one generator to another without any interruption to the motor service, and this advantage is claimed in quite a number of catalogues published by various motor manufacturers throughout the country. It is also a fact that a motor does not require any protection from an interrupted current until the motor has slowed down to an appreciable amount.

The new rules of the National Underwriters' Association for 1902 have a clause which reads as follows: "Motor-starting rheostats must be provided with an automatic release which will prevent the contact arm from being left on intermediate segments and which will release the arm when the voltage across the terminals of the motor falls to thirty-three and one-third per cent of its normal value." While this fall of voltage appears to the writer to be lower than necessary, it was probably true that the committee which drew this rule fixed this as a maximum amount which they would allow the motor to slow down before the protecting device should become operative.

It is well known that any well designed electric motor, such as is in commercial use to-day, will not be injured in the least by an instantaneous flow of current of four to five times its normal rating, although in some cases this abnormal amount of current might produce an undesirable shock to the machinery driven by the motor, in which cases the releasing magnet should be arranged to operate sooner. In the starters manufactured by the General Electric Company, for example, an adjusting screw is provided for this purpose, which regulates the air-gap between the poles of the retaining magnet and its armature. In the types manufactured by the Cutler-Hammer Manufacturing Company, the spools are made interchangeable, the operation requiring about two minutes' time. It is the standard practice of the Cutler-Hammer Manufacturing Company so to wind the spools of the releasing magnet of its starting boxes that they will become operative when the motor has slowed down to approximately one-half its normal speed. It is also quite common to fill specifications which require the releasing magnet to become operative when the motor has slowed down to twenty-five per cent, and in some cases to seventy-five per cent, according to the conditions desired by the particular customer. It is a very easy matter to adjust these releasing magnets when they are connected in the shunt-field circuit of the motor to become operative at almost any desired change in speed of the motor with which they are used.

A very simple way of adjusting the release magnet so that it will let go sooner is to take a one-cent postage stamp and cut it in halves and stick the two pieces upon the pole-pieces of the retaining magnet so that the armature of the rheostat lever will be prevented by the postage stamp from coming in magnetic contact with the poles of the retaining magnet. The cost of this attachment is practically one cent, and is a much simpler and more reliable method than the one suggested by Mr. Heidrich.

Referring again to the article of Mr. Heidrich's, we quote as follows: "The proper winding of the relay can readily be determined by one or two trials." The writer would suggest that while one is winding this relay and attaching the necessary mechanism, etc., he would be able to rewind a good many releasing magnets in such a way as to give him the effect which he seems to desire.

I believe Mr. Heidrich will find on further consideration that the present practice is all right and, while it is doubtless true that he will find and has found starting boxes in use which do not release the rheostat lever until the motor perhaps nearly stops; this is no reason that the standard practice is unreliable, but merely illustrates the fact that motor users are not particular enough in using a release magnet adjusted to the motor which they are operating. The writer respectfully submits that there is no necessity in encumbering a motor starter with the attachment described in Mr. Heidrich's article.

H. H. Cutler.

Chicago, January 17, 1902.

Chicago Electrical Notes.

(By Our Special Correspondent.)

THROUGH the courtesy of Mr. J. W. Brashears, of the Dearborn Drug and Chemical Company, the western office of the Electrical Review was tendered an invitation to attend a lecture on "Electrochemical Industries of Niagara Falls," delivered by Professor Charles F. Chandler, of Columbia University, at the Northwestern University laboratories in Chicago, Wednesday evening, February 5. Professor Chandler, who is known in this country and abroad for his excellent work in the electrochemical field, is especially qualified to discuss the developments at Niagara Falls. He handled the subject with rare skill, inasmuch as those among the guests of the Chicago section of the American Chemical Society, under whose auspices the lecture was given, who were not chemists, were as enthusiastic as the scientists themselves over the wonderful discoveries and achievements in this comparatively new domain of science as described by the speaker. Two hours were devoted to the electrochemical processes by which aluminum is now being extracted from cryolite ores, to the manufacture of cyanide of potash, carbide, sodium, potassium and bleaching powders. The speaker paid a tribute to the American chemists—Acheson, Hall and Kastner—who have contributed so much to the perfecting of these processes.

On the evening of February 15 a number of officials of the Louisiana Purchase Exposition were entertained by the Chicago Press Club at a dinner in the clubrooms. The visit of these gentlemen to Chicago is expected to result in an increase of interest in the great show, not in Chicago alone, but throughout the country. Chicago is the centre of a manufacturing section as well as the centre of population for a large territory, which the St. Louis people expect to contribute much to the success of the exposition. In electrical lines this section will be represented in force.

The Chicago city council, at its meeting on February 13, added to the report of the Committee on Local Transportation a referendum clause which provides that no traction ordinance shall be in effect before it has been submitted to the voters of Chicago as provided by an initiation and referendum act passed in 1901. It seems to be the popular opinion in Chicago that this act of the council was a wise one, and that in future the traction question will not be so difficult of settlement as it has for some time appeared. The matter now rests in the hands of the people, and it is for them, by their ballots, to endorse or destroy any arrangement which may be made between the officials of the city and those of the traction companies.

Chicago, February 15.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

SEEKING ELECTRICAL EXTENSION — The municipality of Worksop, England, is seeking to borrow $425,000 for extensions of the local generating plant and electric light mains and cables.

LARGE CHANGE OF POWER—The syndicate of eastern and western men which has formed the North Shore Railway Company, is preparing to expend $1,000,000 in the improvement of the North Pacific Railroad Company, from Sausalito to Cazadero. Electricity will be substituted for steam between Sausalito, Mill Valley and San Rafael, three suburban towns. Former General Manager Fillmore, of the Southern Pacific Railroad, is now the general manager of the North Shore Railway Company.

TROLLEY COMBINATION EFFECTED—The final steps in a large electric railway combination, in which Cleveland capitalists are directly interested, were taken in a meeting at Hamilton, Ontario, recently. The properties of the Hamilton & Lindenwald Electric Traction Company, including all the lines in the city of Hamilton and the Miamisburg & Germantown Traction Company, were sold to the Southern Ohio Traction Company, which is controlled by M. J. Mandelbaum and associates of this city. The prices paid were, respectively, $250,000 and $100,000.

SOME OF THE THIRD AVENUE LIENS BEING SATISFIED—Several important mechanics liens were satisfied against the Third Avenue Railroad recently. The liens comprise many claims made at the time when insolvency proceedings were begun against the company in February, 1900. They are mainly on construction work and include $1,332,809 for the account of Isaac A. Hopper, $1,042,475 for Naughton & Company and $654 for George C. Austin. Liens were also satisfied against the Manhattanville & St. Nicholas Railway Company for $1,836,945 in favor of Naughton & Company, and $83,234 for the account of the National Conduit and Cable Company, both of New York.

AUSTRALIAN TRACTION SYSTEM—The Ganz Company and the Allgemeine Elektricitats Gesellschaft of Berlin are reported to have come to an understanding with a view to taking common action as regards the securing of contracts for the construction of electric traction systems in Australia. The carrying out of such work has so far been almost entirely in the hands of American concerns—The Sydney system, the most important undertaking of its kind in the Antipodes, being installed with American equipment. The largest Australian traction project at present on the tapis is for the city of Adelaide, the carrying out of which will entail an expenditure of some $6,000,000.

EAST ST. LOUIS RAILWAY TO MERGE—Negotiations are pending for the merging of the East St. Louis Electric Railway by the St. Louis, Belleville & Suburban Railway, with its consummation the Belleville & Suburban company will own all the electric roads operating on the east side. Reports of the deal are repeated as coming from officials of the Belleville company. The St. Louis, Belleville & Suburban Railway belongs to Clark Brothers, prominent financiers and street railway men of Philadelphia. The East St. Louis Electric Railway belongs to the Terminal Railway Association, of St. Louis. Julius Walsh is president of it and W. C. McChesney, vice-president.

A GREAT AFRICAN RAILWAY—The chief subscribers to the Upper Congo & Great African Lakes Railway Company are the Banque de Paris et des Pays Bas ($200,000), the Societe Parisienne pour l' Industrie des Chemins de fer et des Tramways Electriques ($800,000), the Compagnie Belge des Chemins de fer Reunis ($1,000,000), the Compagnie Generale des Chemins de fer a Voie Etroite ($400,000), the Banque Francaise ($200,000), and MM. Rouvier & Benard and a syndicate of Parisian financiers ($750,000). The directorate includes the names of Baron Van Eetvelde, the Belgian Minister of State; M. Empain, of the Paris Metropolitan Electric Railway, and M. Janssen, of the Brussels Tramways.

TELEPHONE AND TELEGRAPH

CANTON, ILL.—The Ipava Automatic Telephone Company, of this place, will commence putting in its exchange system immediately.

SOUTH MILWAUKEE, WIS.—The new telephone system being built by the Wisconsin Telephone Company at South Milwaukee will be ready in about four weeks.

MOLINE, ILL.—The Illinois Independent Telephone Company, which has a franchise to install a system in this city and Rock Island, has forwarded by mail the $5,000 indemnifying bond to Mayor Knox, of Rock Island.

CHESTER, PA.—The United Telegraph and Telephone Company will make improvements to the system in the county that will cost $30,000 as soon as the weather will permit. All wires in the city will be placed under ground.

MUNCIE, IND.—The contract for the wire conduits, poles and other material for the construction of the Delaware & Madison County Telephone Company's system in Muncie has been let and work will begin as soon as the weather permits.

RICHMOND, VA.—The Spotsylvania Telephone Company has bought from the Louisa Telephone Company that part of its line from Belmont to Mine Run, on the Piedmont, Fredericksburg & Potomac Railroad, together with all branch lines.

BALLINGER, TEX.—W. A. Norman, owner and manager of the telephone company, has recently capitalized the Ballinger & Sweetwater Telephone Company, which connects Ballinger with all towns on the Texas and Pacific road which have telephone facilities.

HUDSON, N. Y.—A circular to stockholders of the Hudson Telephone Company announces that the board of directors has voted to issue $400,000 of new stock for construction purposes. This will be offered at the ratio of one share to every eight now held by stockholders.

CAMDEN, N. J.—Work is being pushed by the Keystone Telephone Company, of Philadelphia, looking to the early connection with the Eastern company in Camden, and the time for an extension of the service now being furnished subscribers in this city by the Eastern does not seem far distant.

MASSENA, N. Y.—Arrangements are being made by the Postal Telegraph Company to rebuild its entire line in northern New York, when the frost leaves the ground in the spring. It is claimed the increased business of the company in this section makes this improvement necessary and possible.

TOMAH, WIS.—The work of building the four new telephone lines from St. Paul to Chicago by the American Telephone and Telegraph Company has almost been completed to Tomah from the south and within a few weeks the work, which is being pushed from the north, will reach there and the final connection made.

SUPERIOR, WIS.—The new long-distance line of the Consolidated Telephone and Telegraph will connect with the People's company, of Superior, and the Zenith company, of Duluth. It will give service to Twin City through the line of the Twin City company, and will also have connections with Red Wing, La Crosse and Winona.

WARSAW, IND.—An important meeting of representatives and managers of the independent telephone companies of Fort Wayne, South Bend, Columbia City, Warsaw, Plymouth, Rochester and Logansport has been held and arrangements made to construct in a cooperative way a double or copper metallic line connecting all these important county-seat cities in the network of a first-class system.

PORTSMOUTH, VA.—The Smithfield Telephone Company and the Isle of Wight Telephone Company have consolidated and were merged into a company which shall be known as the Home Telephone Company. Of the consolidated company Mr. J. W. Halloway is president, Mr. B. P. Gray, manager, and Mr. A. S. Barrett, secretary and treasurer. These, with Messrs. P. D. Gwaltney, P. T. Gwaltney, Jr., Z. W. Joyner and F. R. Berryman, are directors.

TOPEKA, KAN.—The Kansas Long-Distance Telephone and Telegraph Company is being organized for the purpose of affording long-distance facilities to operating independent companies in the state and to build long-distance lines in other states, or to arrange for an interchange of business with the systems of other states. Full metallic circuits will be used, and a minute-rate will be charged for service. The company is capitalized at $500,000, and the charter directors are: Fred DeLand, Pittsburgh, Pa.; M. S. DeLand, Pittsburgh, Pa.; L. A. Stebbins, Topeka; C. J. Evans, Topeka; D. H. Branaman, Topeka.

ELECTRIC RAILWAYS

TIPTON, IND.—A company is being organized to build an electric line from Elwood to Fortville *via* Perkinsville.

SANDUSKY, OHIO—The Bucyrus, Upper Sandusky & Lima Railway Company, Upper Sandusky, has been incorporated with a capital of $100,000.

PLAIN CITY, OHIO—The city council has extended the ordinance granting a franchise to the Urbana, Mechanicsburg & Columbus Electric Railway until September 1.

NEW PHILADELPHIA, OHIO—The commissioners have passed a resolution granting a ninety days' extension to the projectors of the Canton-New Philadelphia Railway.

MASSILLON, OHIO—An ordinance granting a franchise for twenty-five years to the Canton, Massillon & Akron Electric Railway Company has been passed by the city council.

SANDUSKY, OHIO—The affairs of the Norwalk & Tiffin Electric Railway are being so arranged that the work of construction can be commenced as soon as the weather permits.

OWINGSVILLE, KY.—There is talk here of an electric railway, which is to be built from Lexington to all important points in the Bluegrass, coming to this town. It will open up a great and wealthy territory.

SHAMOKIN, PA.—Bonds to the amount of $300,000 have been issued and arrangements have been about completed for the construction by the Schuylkill Traction Company of the new line between St. Clair and Mahanoy City.

BAY CITY, MICH.—Bay City & Northeastern will be the name of the proposed electric road from Bay City into Tuscola and Huron counties. The organization is being successfully financed and should materialize very soon.

ELMIRA, N. Y.—The promoters of the Elmira & Waverly electric railroad are steadily working on the plans of the road and according to their present intentions intend to begin the construction as soon as the weather permits in the spring.

VERSAILLES, CT.—The selectmen of the town of Sprague have approved the plans of the Willimantic Traction Company, with a few alterations, as regards placing of rails. The changes were slight and the matter now rests entirely with the Traction company.

BERLIN, N. H.—The prospects of the Berlin Electric Railway Company are very promising, and it is now assured that the road will be built this spring. Nearly all of the materials have been purchased, and some five thousand ties have already been distributed along the route.

LOS ANGELES, CAL.—Construction of an electric railway to and from Santa Ana by way of Whittier will be the achievement of Henry E. Huntington and his associates immediately after the road to Long Beach has been completed. That line is to be ready for service early in the summer.

ALBANY, N. Y.—The Buffalo, Springville & Cattaraugus Railway Company has been incorporated with a capital of $1,000,000 to operate a street surface railway line thirty-eight miles long from Cattaraugus, Cattaraugus County, to Hamburg, Erie County. The road is to be operated by power.

OKLAHOMA CITY, OKLA.—The city council has granted a street car franchise to the Metropolitan Street Railway Company. The company is incorporated with a capital stock of $500,000. The directors are S. T. Alton, E. H. Cooke, J. W. Shartel, Dr. John Threadgill and W. W. Storm. The material will be ordered at once and work on the line will begin within the next thirty days.

SEATTLE, WASH.—If certain requests which the Seattle Electric Company has made of the city council are granted, and its plans approved, the company will expend in Seattle during the year over $1,000,000. The undertakings of the company are of great magnitude. They involve the construction of several new lines and the purchase of a very large amount of new equipment.

KITTANNING, PA.—The Evergreen Street Railway Company, of Pittsburgh, has filed papers in Butler, Lawrence and Armstrong counties looking to an extension of its projected electric line to take in Kittanning, Butler, Newcastle and a large number of the smaller towns. It will, in fact, if the present plans are carried out, be one of the most extensive systems in the state.

CANTON, OHIO—It is stated authoritatively that the Northern Ohio Traction Company, the Everett-Moore Syndicate, and Henry Everett have sold to eastern capitalists their interests in the Canton-Akron Street Railway line, now being constructed between Akron and Canton, and the Canton & Massillon street car systems, as well as the Canton-Massillon interurban line, with the extension to Navarre, five miles south from Massillon.

MCKEESPORT, PA.—The owners of the Pittsburgh, McKeesport & Connellsville Railroad have practically concluded negotiations for the consolidation of the railroad with the electric lighting plants in the principal towns through which the road passes. The bonds of the traction company, amounting to $3,765,000, will be assumed by the Youghiogheny Light and Power Company to be formed by the Pittsburgh capitalists in conjunction with New York men now being interested.

LEGAL NOTES

INFRINGEMENT SUIT—The General Electric Company, of New York city, has filed a bill of complaint in the United States Court against the Wagner Electric Manufacturing Company, of St. Louis, Mo. It is alleged that the latter company has been engaged in the manufacture of electric transformers which are an infringement on patents granted to Walter S. Moody, of Lynn, Mass., in 1897.

BRUSH PATENT SUSTAINED—Judge Lacombe, of the United States Circuit Court, Southern District of New York, has rendered a decision which again sustains the validity of the Brush storage battery patent, owned by the Electric Storage Battery Company, and has granted an order restraining the Porter Battery Company from the further manufacture, sale, or use in any manner whatsoever of storage or secondary battery elements which infringe this patent.

ELECTRIC LIGHTING

BURNS, ORE.—A franchise has been granted for the erection of an electric light plant at Burns.

WILTON, ME.—A plan is being formulated to construct facilities for furnishing light and power for the town.

NEWFANE, N. Y.—A contract for lighting the village has been awarded to the Newfane Electric Company, a Lockport corporation.

FORT EDWARD, N. Y.—The National Gas and Electric Light Company, of Sand Hill, has been incorporated with a capital of $51,000.

ROCKAWAY, N. J.—The Rockaway Electric Light and Improvement Company will, in a short time, extend its line to Mount Arbor and Denville.

CINCINNATI, OHIO—The public library trustees have appropriated $4,000 for a new electric lighting plant upon recommendation of the building committee.

RENOVO, PA.—The town council has ordered the police and light committee to sign a contract for lighting the streets with the Edison Light, Heat and Power Company.

CANASTOTA, N. Y.—At a recent special meeting of the village trustees, it was voted to sign a five-year contract with the Canastota Electric Light and Power Company.

LANCASTER, PA.—The Edison Electric Light Company has contracted with the Lancaster Electric Light, Heat and Power Company for all its power. This practically absorbs the latter company.

BALLSTON SPA, N. Y.—Negotiations are under way with the Ballston Spa Light and Power Company for the purchase of its plant and franchise in this village by the Ballston Terminal Railroad Company.

RIPON, WIS.—The Ripon Light and Water Company has installed at its pumping station a 500-horse-power Corliss engine and a new arc dynamo and condenser. A new boiler and switchboard have also been added.

ROME, N. Y.—The work of changing the machinery at the plant of the Rome Gas, Electric Light and Power Company, which has been under way for the past seven or eight months, is rapidly nearing completion and the finishing touches will soon be put on.

MANCHESTER, N. H.—The Amoskeag Manufacturing Company, a large textile manufacturer, is about to install an electrical plant of some 2,500 horse-power, which will be used to run its weaving mills on both sides of the river, and also operate 125 arc and 500 incandescent lamps.

BIRMINGHAM, ALA.—The annual meeting of the Birmingham Railway, Light and Power Company was held recently, and the following board of directors elected: B. F. Roden, A. M. Shook, H. M. Atkinson, J. K. Newman, Nat. Baxter, W. H. Kettig, G. B. McCormack, N. E. Barker, M. V. Joseph, R. H. Pearson, Gordon Abbott, Robert Jemison, S. H. March, George H. Davis.

ELECTRICAL SECURITIES

The Wall street community was subjected to a severe shock during the week just closed, due to the agitation of the question of enforcement by the authorities of the tax upon call loans and substitutions in collateral to secure such loans. It is particularly unfortunate that this agitation should come at this time, as the bill in Congress to repeal the entire war tax measure is now in a fair way of early passage. Strong pressure will be brought to bear upon the administration to prevent the adoption of this attitude by the revenue officials.

The main speculative conditions have shown improvement during the week. There has been some good increases noted during the week in the outside public markets, especially in investments. This is reflected in the very strong and active bond market, and also in the demand for securities that are classed as investments.

ELECTRICAL SECURITIES FOR WEEK ENDING FEBRUARY 15.

New York:	Closing.
Brooklyn R. T.	62⅞
Con. Gas	220⅝
Gen. Elec	291
Man. El	134
Met. St. Ry	171
Nings. Co. Elec	191
N. Y. & N. J. Tel. Co	169
Telep., Tel. & Cbl. Co	5

Interest has been largely centered in the traction stocks as was natural in view of the developments in regard to Brooklyn Rapid Transit and Metropolitan Street Railway. There is no ignoring the fact that the proposed new bond issue of $150,000,000 by the Brooklyn Rapid Transit Company has acted as a decided check upon market bullishness, and the financial plan announced by the Metropolitan company, by which that system proposes to raise new funds to the amount of $30,000,000, has also proved far from a stimulating factor.

Boston:	Closing
Am. Telep. & Tel.	158
Edison Elec.	260
Erie Tel.	20
New Eng. Tel.	140½
Mass. Elec. pf.	96¼
Westing. Mfg. pf.	89½
Western Telephone & Telegraph	93

There was little feature in Boston trading. Massachusetts Electric continued active, supplying a third of the total dealings in listed stocks. Common touched 37½ and 37⅝, closing at 37¼, a net gain for the week of 2½, while preferred rose 1¼ to 96¼, a gain of 2 for the week.

American Telephone went slightly lower.

Philadelphia:	Closing.
Elec. Co. of America	6⅛
Philadelphia Elec	3¾
Union Traction	36
United G. I. Co	119
Elec. Stor. Bat. c	62
Elec. Stor. Bat. pf	65

A member of the Union Traction Committee which has the Rapid Transit negotiations in hand, says it is quite unlikely that the proposition will be in such shape as to announce publicly after the next regular meeting of the board. It is understood the proposition for lease of Union Traction will be consummated this week. It has been decided that the new road which is to be built on Market street will be elevated.

Chicago:	Closing.
Central Union Tel	40
Chicago Edison Light	165
Chicago Telep	185
Metropolitan El. pf	89¼
National Carbon	20
National Carbon pf	84
Union Traction	15
Union Traction pf	47½

PERSONAL MENTION

MR. THOMAS L. TOWNSEND has accepted the general management of the Vallee Brothers Electrical Company, of Philadelphia.

MR. RALPH STRASCHNOW has accepted the management of the sales department for Stanley & Patterson, supply dealers, of New York.

MR. C. E. KAMMEYER has resumed the management of the *Telephone Magazine*, published at Chicago. The office of the journal will be in the Medinah Temple, Chicago. Mr. Kammeyer was the editor of the journal several years ago.

COLONEL HENRY S. KEARNY, who was until recently head of the Public Building Department, has succeeded Judge J. M. Thomas as president of the Telephone, Telegraph and Cable Company of America, with headquarters at 100 Broadway, New York city.

MR. HERMAN A. STRAUSS has resigned the post of assistant engineer of the Manhattan Elevated Railway Company, which he has held during the past two years, to engage in consulting electrical engineering work, with office in the Park Row Building, New York city.

MR. A. C. WHITE, general manager of the Providence Telephone Company, Providence, R. I., was a New York visitor last week. Mr. White who has been a sufferer from a severe attack of the grip, is much improved in health and soon expects to be entirely recovered.

MR. M. J. BUDLONG, of Chicago, Ill., has been appointed treasurer of the Electric Vehicle Company, Hartford, Ct., to succeed Mr. Fred Viewig, of New York, resigned. Mr. Budlong has, at different times, been associated with the Pope Manufacturing Company, the Siemens & Halske Electric Company, and the Riker Company.

MR. WM. H. MCKINLOCK, president of the Metropolitan Electrical Supply Company, of Chicago, was a New York and Boston visitor this week. Mr. McKinlock is interested in a novel invention that locks an incandescent lamp in its socket, a new device that is meeting with much favor at the hands of owners of isolated plants as well as electric light companies in general.

WILLIAM LISPENARD ROBB, Ph. D., professor of physics in Trinity College, Hartford, Ct., under whose supervision the mines in New York Harbor were laid previous to the breaking out of the Spanish-American War, has been called to the newly established professorship of electrical engineering at the Rensselaer Polytechnic Institute, Troy, N. Y., and it is probable that he will accept. Dr. Robb is one of the foremost electrical experts of the country. He is a graduate of Columbia University.

NEW INCORPORATIONS

XENIA, OHIO—Xenia, Jamestown & Wilmington Electric Railway Company. $1,000.

EL DORADO, PA.—Butler Telephone Company. $7,000. To build telephone lines and put in other electrical apparatus.

DEWITT, IOWA—The DeWitt Telephone Company. $15,000. Incorporators: C. H. Arthur, A. M. Price, L. W. Large and others.

STEVENS POINT, WIS.—Wisconsin Central Telephone Company. $200,000. Incorporators: A. L. Hutchinson, H. G. Slater and others.

COLUMBUS, OHIO—The Columbus Motor Vehicle Company. $50,000. To manufacture and sell automobiles and vehicles containing their own power of propulsion. The incorporators are from this city.

SPRINGFIELD, ILL.—The Interstate Independent Telephone and Telegraph Company, of Jersey City, N. J., was licensed to do business in Illinois; capital stock, $3,000,000; capital in Illinois, $600,000.

PITTSBURG, KAN.—Pittsburg Telephone Company. $50,000. To build and operate a telephone plant at Pittsburg. Stockholders: Grant Hornaday, W. B. Hurst, C. W. Penniman and others, of Fort Scott.

SOUTH BEND, IND.—The South Bend Home Telegraph Company. $200,000. To operate an independent telephone system in South Bend. Incorporators: E. H. Miller, M. B. Staley, D. D. Bates and others.

MECHANICSVILLE, N. Y.—The Halfmoon Transmitter Company. $500,000. To manufacture all kinds of electric power transmitting machinery. Thomas Greenwood, Patrick Egan and Michael J. Egan are the incorporators and first directors.

TRENTON, N. J.—The United States Light and Heating Company. $3,000,000. To furnish electricity, light and heat, especially for railways and railway cars. Incorporators: William B. Irwin, Wallace Young and John J. Gilbert, all of Jersey City, N. J.

JERSEY CITY, N. J.—National Light Supply Company, Bloomfield, N. J., manufacturer of lighting supplies. $50,000. Incorporators: Irvin H. Brown, Plainfield, N. J.; Harry B. Perkins, 43 Delmont avenue, East Cleveland, Ohio; William E. Billings, 34 Gramercy Park, New York city.

FT. WAYNE, IND.—The Gas Belt Construction Company. $100,000. To manufacture telephone instruments, switchboards and everything connected with a telephone system. The company will operate in Madison and Delaware counties. Directors: Wayne Leeson, George W. Beers and others.

INDIANAPOLIS, IND.—The Smith Construction Company, of Indianapolis, has filed incorporation papers at the State House. The purpose is to build the Indianapolis & Western Traction Company line from Indianapolis to Plainfield and Danville. The capital stock is $25,000 and the directors are Arthur B. Hogue, Amory T. Irwin and Edward G. Hendrickson. The Indianapolis & Western Traction Company has increased its capital stock from $100,000 to $500,000.

INDUSTRIAL ITEMS

MR. L. W. KUTSCHE, Chicago, Ill., has been awarded the contract to wire the court house and jail of La Salle County, Ill., located in Ottawa.

THE ELECTRICAL CONTRACTING AND REPAIRING COMPANY, formerly of Ithaca, N. Y., has established its business at 391 Myrtle avenue, Brooklyn, N. Y.

THE ACME TELEPHONE COMPANY, New York, is making a shipment of telephone apparatus to Bombay, for the equipment of one of the largest office buildings in that city.

THE LACHINE RAPIDS HYDRAULIC AND LAND COMPANY, LIMITED, R. S. Kelsch, chief engineer, 160 McCord street, Montreal, Canada, is about to begin plans on a large substation, including an auxiliary steam plant of 6,000 to 8,000 horse-power capacity.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, 1992 West Van Buren street, Chicago, is manufacturing a new wireless cluster for electric lighting which has been approved by the underwriters, and which may be used in either ceiling, pendent or weather-proof forms.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I., will mail upon request its new 1902 catalogue. This book contains 441 pages, and considerable additions to its lines, as well as tables and general information, make it a very desirable and interesting work of reference.

THE FOSTER ENGINEERING COMPANY, Newark, N. J., manufactures the Foster pressure regulator (reducing valve) and other high-grade specialties for water, gas or air. This company is distributing an attractively printed catalogue, which contains a large number of illustrations and complete information.

THE CHASE-SHAWMUT COMPANY, Boston, Mass., manufacturer of electrical specialties, has secured large and commodious quarters and are now manufacturing a full line of fuse wire, fuse links and enclosed fuses, railbonds, junction boxes, nipples and couplings and cable clips, and is in a position to make prompt deliveries on same.

THE WOTTON ELECTRICAL MANUFACTURING COMPANY, Atlanta, Ga., is manufacturing a loud ringing extension bell, especially desirable for telephone service where the instruments are to be placed in noisy places. These bells are wound to any required resistance, and are mounted on hard wood bases, finished in various styles of wood.

THE D. M. STEWARD MANUFACTURING COMPANY, of Chattanooga, Tenn., manufacturer of the "Lava" insulating material, has placed on the market a new preparation known as "Stainoff" for cleaning ink and stains from the hands. The compound is said to be harmless and desirable for stenographers, bookkeepers, housekeepers, printers, painters, engravers, machinists and electricians.

THE MILWAUKEE ELECTRIC COMPANY, Milwaukee, Wis., will be "at home" in its new factory about March 1. Work was delayed to some extent by inability of the contractors to secure structural steel for the buildings. The new home of this progressive manufacturing concern will be equipped with all modern conveniences, and will be in thorough accord with the excellent machines which it produces.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY has just closed a contract with the Rensselaer Telephone Company, Troy, N. Y., for one of its "Major" relay-type switchboards of 3,000 lines capacity, with a present capacity of 1,500 lines. Included in this contract is all necessary power apparatus, chief operator's desk, wire chief's desk, and a toll board of 100 lines capacity, with present equipment of forty lines.

THE BAIRD MANUFACTURING COMPANY, Chicago, Ill., manufactures the automatic electric switch referred to in these columns last week. The device was thoroughly tried before it was placed on the market. In fact the several working models were built and placed in actual service in Chicago business houses several months since. The switch has proved so satisfactory that the manufacturers guarantee all they sell.

THE INDUSTRIAL MACHINE COMPANY, Phœnix, N. Y., is sending to prospective purchasers a complete description of its improved motor-bicycle and also striking photographs of this machine in two positions. This machine is known as the De Long motorcycle, and the motive power is hydrocarbon with electric spark ignition. The whole weight is about sixty pounds and the machine appears to possess many points of advantage.

THE ACME ILLUMINATING AND MANUFACTURING COMPANY, Chicago, Ill., has removed its factory and offices from 155 to 152 Fifth avenue. The company made the change on account of a fire in the former building which occurred on January 5, and because it needed more space for the new machinery it was about to install. It is now turning out a number of new lighting devices and will be glad to furnish catalogue to all who are interested.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is advertising "American" conduit, formerly "Richmondt." The American Interior Conduit Company, the manufacturer of Richmondt electro-galvanized conduit and fittings, has decided to change the name of its product to confirm with the name of the company. There is nothing changed but the name, however, unless it is the facilities for handling an increasing business more satisfactorily for the trade.

THE INTERNATIONAL MOTOR CAR COMPANY, Toledo, Ohio, has just successfully consummated a severe trial of its motor vehicle. Oliver Lippincott, the Los Angeles artist, in his automobile, "Toledo," climbed "Knob Hill," Flagstaff, Ariz., a sixteen per cent grade, in six inches of snow, in a test before a committee of the new automobile company, between that place and the Grand Canyon. The demonstration is considered very difficult and the results are very gratifying to the company.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., has published a bulletin on "Protective Devices." It describes the S. K. C. switchboard and pole-line fusible cutouts, including the 30,000-volt "ball fuse" and the type "F" high-capacity fuse. A combined oil switch and circuit-breaker switch, the circuit-breaker of the slide type, each break of which is provided with an arc-rupturing shutter, are also illustrated and described. The S. K. C. secondary protector, lightning arrester, ground detectors, etc., are other subjects of this publication. The bulletin is illustrated and is a comprehensive treatise of the subject covered, and will be sent gratuitously to those interested upon request.

THE LOMBARD GOVERNOR COMPANY, Boston, Mass., has just issued a very neat and attractive catalogue illustrating its different types of water wheel and steam engine governors and allied appliances. As the Lombard Governor Company has under control by its governors over 300,000 horse-power of water wheels in this country alone, some idea may be had of the rapid strides first-class speed regulation has made within a comparative short time. From this fact alone the new catalogue is well worth the reading. Concise and accurate descriptions of all types of Lombard governors are given, while several good photographic illustrations of modern plants with tables are included within its covers.

"THE FOUR-TRACK NEWS," the monthly magazine of travel and education published by the passenger department of the New York Central & Hudson River Railroad, has issued its February number which is not only beautifully illustrated but contains a vast amount of interesting and appropriate text. Among the illustrations are the following: Niagara Falls in winter, showing the ice bridge and ice mountains, a typical southern California home, Grand Canon of Arizona, Colorado cliff dwellings and the famous railroad loop near Denver. General Passenger Agent George H. Daniels, who is responsible for this unique and interesting publication, is entitled to congratulations over the success with which this monthly magazine has been received.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed a number of large contracts for batteries of the chloride accumulator to be installed in electric railway power-houses and substations for the purpose of regulation and peak work. Among these are three installations recently contracted for by the Twin City Rapid Transit Company, Minneapolis, Minn., two of which consist of 288 cells each, installed in Minneapolis, Minn., and St. Paul, respectively; these have a nominal capacity of 1,000 kilowatts, and are operated in conjunction with motor-driven boosters for regulating and peak work. The third battery for this company is to be installed in a substation at Stillwater, seven and one-half miles distant from the power-house. This battery consists of 315 cells, having a capacity for one hour of 400 kilowatts, and is to be used with shunt booster entirely for regulating the line voltage. These three batteries have tanks sufficiently large to allow of an ultimate increase of fifty per cent greater capacity.